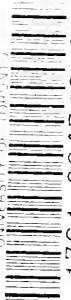


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THE
ANATOMY AND PHYSIOLOGY
OF
THE HUMAN BODY.

CONTAINING

THE ANATOMY

OF THE BONES, MUSCLES, AND JOINTS; AND THE HEART AND
ARTERIES:

BY JOHN BELL;

AND

THE ANATOMY AND PHYSIOLOGY

OF THE BRAIN AND NERVES, THE ORGANS OF THE SENSES,
AND THE VISCERA:

BY CHARLES BELL, F. R. S. E.

SURGEON TO THE MIDDLESEX HOSPITAL, AND READER OF ANATOMY
IN THE CHAIR OF DR. HUNTER, &c. &c.

FOURTH AMERICAN, FROM THE FOURTH ENGLISH EDITION.
IN THREE VOLUMES.

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TO
ALEXANDER WOOD,
SURGEON ;

WHOSE ABILITIES AND SKILL, AND DISINTERESTED CONDUCT,
HAVE RAISED HIM, BY COMMON CONSENT,
TO THE FIRST RANK,

IN A MOST USEFUL PROFESSION :

CONDUCTING HIM, IN HONOUR, TO THAT PERIOD OF LIFE,
IN WHICH HE MUST FEEL WITH PLEASURE,

HOW COMPLETELY HE ENJOYS THE

CONFIDENCE OF THE PUBLIC,

AND THE ESTEEM OF ALL GOOD MEN,

THIS BOOK OF ANATOMY

IS PRESENTED,

BY HIS PUPIL,

JOHN BELL.

1877

THE
ANATOMY
OF THE
HUMAN BODY.

VOL. I.

CONTAINING
THE ANATOMY
OF
THE BONES, MUSCLES, AND JOINTS, THE
HEART AND CIRCULATION,
AND
THE LUNGS.

(1-211)

1. The first part of the document is a list of names and addresses of the members of the committee. The names are listed in alphabetical order, and the addresses are given in full. The list is as follows:

Name	Address
Mr. A. B. C.	123 Main St., New York, N. Y.
Mr. D. E. F.	456 Broadway, New York, N. Y.
Mr. G. H. I.	789 Fifth Ave., New York, N. Y.
Mr. J. K. L.	1010 Third Ave., New York, N. Y.
Mr. M. N. O.	1111 Second Ave., New York, N. Y.
Mr. P. Q. R.	1212 First Ave., New York, N. Y.
Mr. S. T. U.	1313 West 125th St., New York, N. Y.
Mr. V. W. X.	1414 East 125th St., New York, N. Y.
Mr. Y. Z. A.	1515 West 125th St., New York, N. Y.
Mr. B. C. D.	1616 East 125th St., New York, N. Y.
Mr. E. F. G.	1717 West 125th St., New York, N. Y.
Mr. H. I. J.	1818 East 125th St., New York, N. Y.
Mr. K. L. M.	1919 West 125th St., New York, N. Y.
Mr. N. O. P.	2020 East 125th St., New York, N. Y.
Mr. Q. R. S.	2121 West 125th St., New York, N. Y.
Mr. T. U. V.	2222 East 125th St., New York, N. Y.
Mr. W. X. Y.	2323 West 125th St., New York, N. Y.
Mr. Z. A. B.	2424 East 125th St., New York, N. Y.
Mr. C. D. E.	2525 West 125th St., New York, N. Y.
Mr. F. G. H.	2626 East 125th St., New York, N. Y.
Mr. I. J. K.	2727 West 125th St., New York, N. Y.
Mr. L. M. N.	2828 East 125th St., New York, N. Y.
Mr. O. P. Q.	2929 West 125th St., New York, N. Y.
Mr. R. S. T.	3030 East 125th St., New York, N. Y.
Mr. U. V. W.	3131 West 125th St., New York, N. Y.
Mr. X. Y. Z.	3232 East 125th St., New York, N. Y.
Mr. A. B. C.	3333 West 125th St., New York, N. Y.
Mr. D. E. F.	3434 East 125th St., New York, N. Y.
Mr. G. H. I.	3535 West 125th St., New York, N. Y.
Mr. J. K. L.	3636 East 125th St., New York, N. Y.
Mr. M. N. O.	3737 West 125th St., New York, N. Y.
Mr. P. Q. R.	3838 East 125th St., New York, N. Y.
Mr. S. T. U.	3939 West 125th St., New York, N. Y.
Mr. V. W. X.	4040 East 125th St., New York, N. Y.
Mr. Y. Z. A.	4141 West 125th St., New York, N. Y.
Mr. B. C. D.	4242 East 125th St., New York, N. Y.
Mr. E. F. G.	4343 West 125th St., New York, N. Y.
Mr. H. I. J.	4444 East 125th St., New York, N. Y.
Mr. K. L. M.	4545 West 125th St., New York, N. Y.
Mr. N. O. P.	4646 East 125th St., New York, N. Y.
Mr. Q. R. S.	4747 West 125th St., New York, N. Y.
Mr. T. U. V.	4848 East 125th St., New York, N. Y.
Mr. W. X. Y.	4949 West 125th St., New York, N. Y.
Mr. Z. A. B.	5050 East 125th St., New York, N. Y.

PREFACE.

TO those, who are at all acquainted with books on anatomy, the appearance of a new one on the subject will not be surprising. To those, who are not yet acquainted with such writings, I have only to say that I have written this book, because I believed that such a one was needed, and must be useful. I have endeavoured to make it so plain and simple as to be easily understood; I have avoided the tedious interlarding of technical terms, (which has been too long the pride of anatomists and the disgrace of their science,) so that it may read smoothly, compared with the studied harshness, and I may say, obscurity of anatomical description. If an author may ever be allowed to compare his book with others it must be in the mechanical part; and I may venture to say, that this book is full and correct in the anatomy, free and general in the explanations, not redundant, I hope, and yet not too brief.

If, in the course of this volume, I shall appear to have given a place and importance to theories far higher than they really deserve, my reader will naturally feel how useful they are in preserving the due balance between what is amusing, and what is useful; between the looser doctrines of functions, and the close demonstration of parts. He will be sensible, how much more easily these things can be read in the closet, than taught in any public course; he will, I think, be ready to ac-

knowledge, that I introduce such theories only, as should connect the whole, and may be fairly distinguished as the physiology of acts : and he will perceive, that in this too, I feel a deference for the public opinion, and a respect for the established course of education, which it is natural to feel and to comply with.

Thus, perhaps it is less immodest for an author to put down what he thinks he may honestly say concerning his own book, than to omit those apologies which custom requires, which give assurance, that he has not entered upon his task rashly, nor performed it without some labour and thought, and which are the truest signs of his respect for the public, and of his care for that science to which he has devoted his life.

With these intentions and hopes, I offer this book to the public ; and more particularly to those in whose education I have a chief concern ; not without a degree of satisfaction at having accomplished what I think cannot fail to be useful, and surely not without an apprehension of not having done (in this wide and difficult subject) all that may be expected or wished for.

Every book of this kind should form a part of some greater system of education : it should not only be entire in its own plan, but should be as a part of some greater whole ; without which support and connexion, a book of science is insulated and lost. This relation and subserviency of his own particular task to some greater whole, is first in an author's mind : he ventures to look forward to its connexion with the general science, and common course of education ; or he turns it to a correspondence and harmony with his own notions of study ; and if these notions are to give the complexion and character to any book, it should be when it is designed for those entering upon their studies, as yet uncertain where to begin, or how to proceed.

Hardly any one has been so fortunate as to pursue the study of his own science under any regular and perfect plan ; and there are very few with whom a consciousness of this does not make a deep and serious impression at some future period, accompanied with severe

regret for the loss of time never to be retrieved. In medicine, perhaps, more than in any other science, we begin our studies thoughtless and undecided, following whatever is delightful, (as much is delightful,) neglecting the more severe and useful parts : but as we advance towards that period in which we are to enter upon a most difficult profession, and to take our place and station in life, and when we think of the hesitation, anxiety, and apprehension with which we must move through the first years of practice, we begin to look back with regret on every moment that is past ; with a consciousness of some idle hours ; and (what is more afflicting still) with an unavailing sense of much ill-directed, unprofitable labour :—for there is no study which a young man enters upon with a more eager curiosity ; but not instructed in what is really useful, nor seriously impressed with the importance of his future profession, he thinks of his studies rather as the amusement, than as the business, of life ; slumbers through his more laborious and useful tasks, and soon falls off to the vain pursuit of theories and doctrines.

If I were not persuaded of the important consequences, of the infinite gain or loss, which must follow the first steps in every profession, I should not feel, but, above all, I should not venture to show, an anxiety, which may be thought affected by those who cannot know how sincere it must be ; for, in our profession, this is the course of things, that a young man, who, by his limited fortune, or the will of his friends, by absence from his native country, or by the destination of his future life, is restricted to a few years of irregular, capricious, ill directed study, throws himself at once into the practice of a profession, in which, according to his ignorance or skill, he must do much good or much harm. Here there is no time for his excursions into that region of airy and fleeting visions, and for his returning again to sedate and useful labour : there is no time for his discovering, by the natural force of his own reason, how vain all speculations are :—in but a few years, at most, his education is determined ; the limited term is com-

pleted, ere he have learnt that most useful of all lessons—the true plan of study ; his opportunities come to be valued (like every other happiness) only when they are lost and gone.

Of all the lessons which a young man entering upon our profession needs to learn, this is, perhaps, the first,—that he should resist the fascinations of doctrines and hypotheses, till he have won the privilege of such studies by honest labour, and a faithful pursuit of real and useful knowledge. Of this knowledge, anatomy surely forms the greatest share.—Anatomy, even while it is neglected, is universally acknowledged to be the very basis of all medical skill.—It is by anatomy that the physician guesses at the seat, or causes, or consequences, of any internal disease : without anatomy, the surgeon could not move one step in his great operations : and those theories could not even be conceived, which so often usurp the place of that very science, from which they should flow as probabilities and conjectures only, drawn from its store of facts.

A consciousness of the high value of anatomical knowledge never entirely leaves the mind of the student. He begins with a strong conviction that this is the great study, and with an ardent desire to master all its difficulties : if he relaxes in the pursuit, it is from the difficulties of the task, and the seduction of theories too little dependent on anatomy, and too easily accessible without its help. His desire for real knowledge revives, only when the opportunity is lost ; when he is to leave the schools of medicine ; when he is to give an account of his studies, with an anxious and oppressed mind, conscious of his ignorance in that branch which is to be received as the chief test of his professional skill ; or when, perhaps, he feels a more serious and manly impression, the difficulty and importance of that art which he is called to practice.

Yet, in spite of feeling and reason, the student encourages in himself a taste for speculations and theories, the idle amusements of the day, which even in his own short course of study, he may observe sinking in quick

succession into neglect and oblivion, never to revive ; he aspires to the character of a physiologist, to which want of experience and a youthful fancy, have assigned a rank and importance which it does not hold in the estimation of those who should best know its weakness or strength. The rawest student, proud of his physiological knowledge, boasts of a science and a name which is modestly disclaimed by the first anatomists, and the truest physiologist of this or any age : Dr. Hunter speaks thus of his physiology, and of his anatomical demonstrations : “ Physiology, as far as it is known or has been explained by Haller, and the best of the moderns, may be easily acquired by a student without a master, provided the student is acquainted with philosophy and chemistry, and is an expert and ready anatomist ; for with these qualifications he can read any physiological book, and understand it as fast as he reads.

“ In this age, when so much has been printed upon the subject, there is almost as little inducement to attend lectures upon physiology, as there would be for gentlemen to attend lectures upon government, or upon the history of England. Lectures upon subjects which are perfectly intelligible in print, cannot be of much use, except when given by some man of great abilities, who has laboured the subject, and who has made considerable improvements either in matter or in arrangement.

“ In our branch, those teachers who take but little pains to demonstrate the parts of the body with precision and clearness, but study to captivate young minds with ingenious speculation, will not leave a reputation that will outlive them half a century.

“ I always have studied, and shall continue my endeavours, to employ the time that is given up to anatomical studies as usefully to the students as I can possibly make it—and therefore shall never aim at showing what I know, but labour to show and describe, as clearly as possible, what they ought to know. This plan rejects all declamation, all parade, all wrangling, all subtilty : to make a show, and to appear learned and

“ingenious in natural knowledge, may flatter vanity ; to
“know facts, to separate them from suppositions, to range
“and connect them, to make them plain to ordinary
“capacities, and above all, to point out the useful appli-
“cations, is, in my opinion, much more laudable, and
“shall be the object of my ambition.”*

* Introductory Lecture published by Dr. Hunter.

EDINBURGH, SEPT. 1793.

PREFACE

TO THE
FOURTH EDITION.

IN giving this edition of the Anatomy of the Human Body to the public, I have been careful to revise the descriptions, and have made some additions; so that I hope it will be found to have fewer errors, and to present a more perfect system.

Of the first part of the work by my brother, I may speak more freely. And I may recommend it to those who superintend the education of students, to consider whether they have not in it a work calculated to open the minds of the pupils to the right understanding of the important subjects of their studies, and to give them correct and liberal views of their profession. It will not be soon surpassed in correctness and minuteness of description.

I have not dared to touch the History of the Arteries; the rapid improvement in the surgery of the arteries, which followed as a consequence of the first publication of this part of the Anatomy, has, with me, made it sacred. What is delivered on the compression of the great arteries, is an error on the safe side. I may add, that without the necessity of making experiments on so serious a subject, I have found the strength of my thumb quite sufficient to compress the main artery at the groin, both in wounds of the femoral artery, and in circumstances where I found it necessary to amputate the thigh without the possibility of using the tourniquet. I must, however, acknowledge, that I have seen too much loss of blood from trusting to compression in amputating at the shoulder-joint. I think, in one instance, the patient died from

the loss of blood. Few assistants have strength and dexterity to accomplish the entire compression of the artery in this operation, and such have been my fears of hæmorrhage, that having had occasion to amputate at the shoulder-joint, in order to avoid that danger, I thought myself obliged to deviate from the common manner of performing the operation.

On the subject of the Nerves, my reader will find an account of that system, which I have delivered in my Lectures for ten years past. That I have been so long of placing my own particular views in a systematic work, will only prove my respect for the received opinions : but the manner in which so many of my professional brethren have allowed themselves to be assailed by new and fantastic doctrines, showing little respect for the old, makes me hesitate less in substituting opinions different from those hitherto admitted.

Considerable additions have been made to the Anatomy and Physiology of the Viscera.

CHARLES BELL.

SOHO-SQUARE, LONDON,
JAN. 1816.

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ANATOMY

-OF THE

HEART AND ARTERIES.

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Fig. 1.

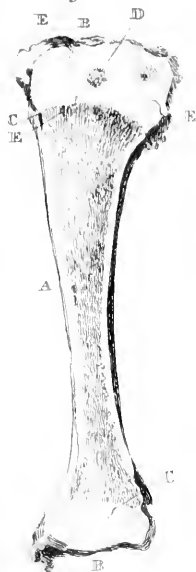


Fig. 3.

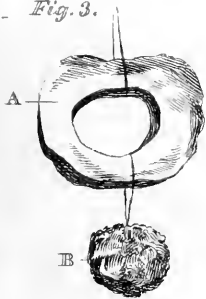


Fig. 2.





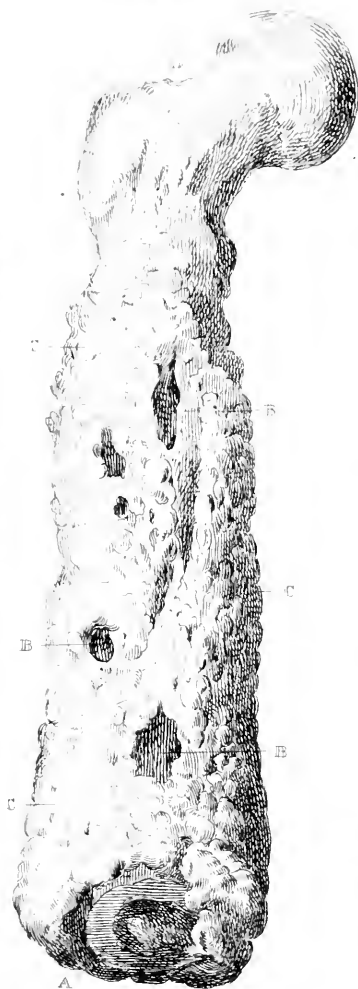
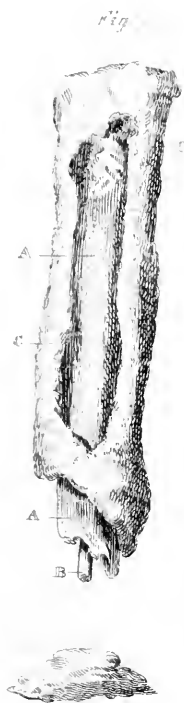




Fig. 1.

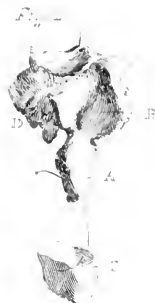
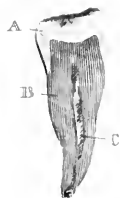


Fig. 3.



Fig. 4.



Fig. 5.

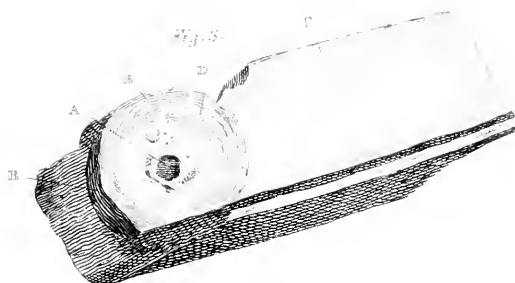
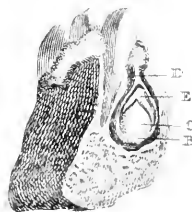
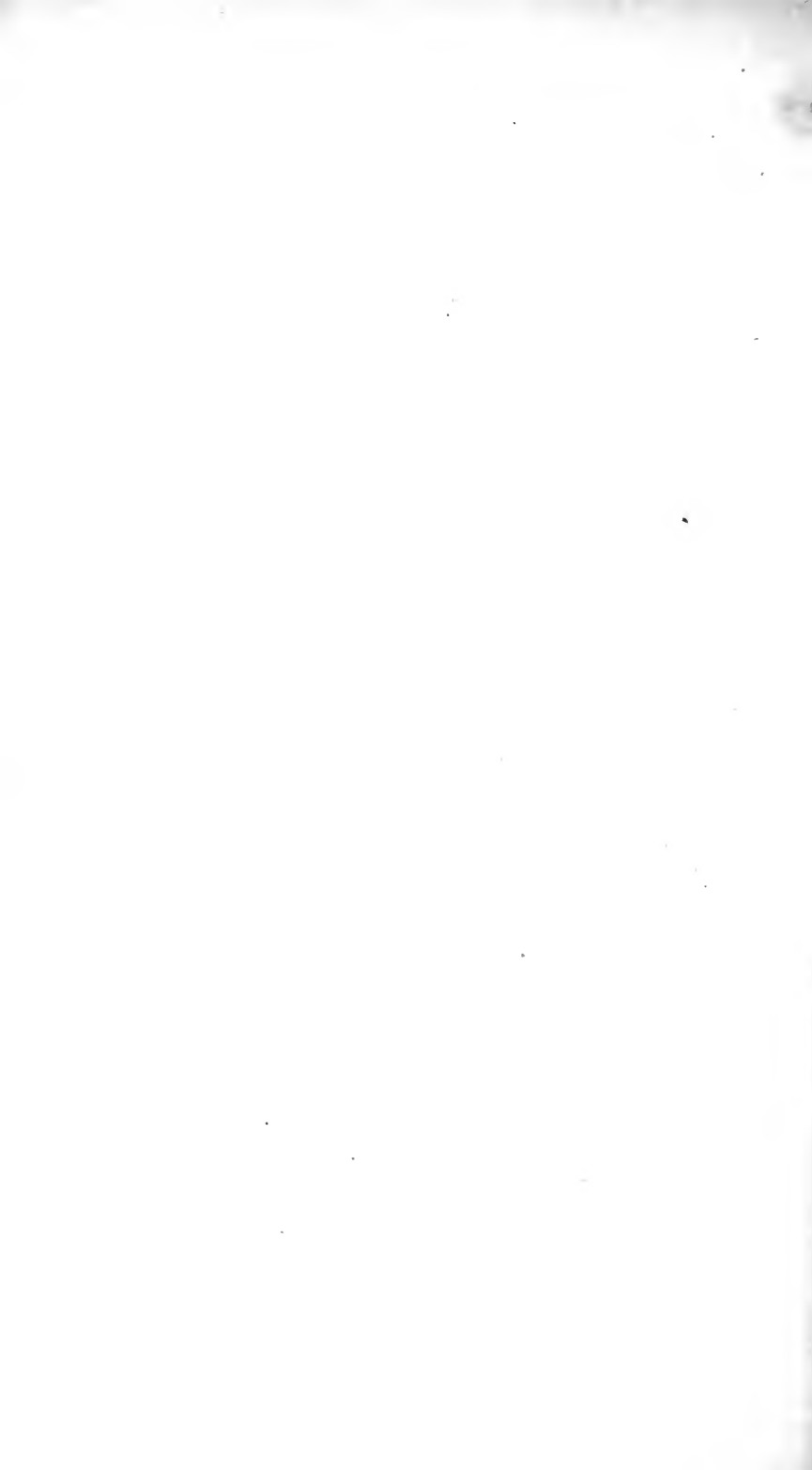


Fig. 6.



Fig. 7.





EXPLANATION

OF

THE PLATES.

PLATE I.

This plate illustrates the description of the manner in which ossification takes place in cartilage.

FIG. 1.

THE tibia of the fœtus cut through after injection of the arteries.

- A. THE BODY OF THE BONE, the centre of which is soft and very vascular.
- BB. The CARTILAGES, which are as yet in place of the heads of the bone.
- CC. Vessels seen to penetrate the cartilage from the vascular extremity of the bone itself.
- D. A central nucleus of bone forming in the cartilage.
- EE. Vessels penetrating from perichondrium into the cartilage: small specks of bony matter are seen to be formed by their extremities.

FIG. 2.

A section of the bones forming the knee joint of a child, showing how the apophysis is formed.

- A. Section of the femur, where the bone is complete.
- B. The cartilaginous extremity, as in fig. 1.
- C. A larger mass of bone formed in the cartilage, and which extending, in a short time would have occupied the place of the whole cartilage. The tract of vessels supplying the bone, and which were not visible in the cartilage, are also represented here.
- D. The patella, as yet a cartilage.
- E. The Upper extremity of the tibia, yet a cartilage.
- F. The bone forming in the cartilage.

FIG. 3.

Represents a section of the apophysis of a young bone ; the bony nucleus separated from the cartilage by maceration.

- A. The cartilage.
- B. The bone.

EXPLANATION OF PLATE II.

Explaining the obscure subject of necrosis, or death of a bone, and regeneration of a new one in its stead.

FIG. 1.

The bone of a cock's leg, which was perforated, and a feather introduced into the cavity of the bone—the consequence necrosis.

- AA. The old bone dark yellow, and not partaking of the injection, because, though retained in its place, dead.
- c. The new bone formed around the old cylinder of bone, and uniting with the end of the old bone.
- B. The end of the feather, which, as a foreign body within the bone, first caused the bone to inflame and throw out new matter, and still continuing a source of irritation, killed the bone.

FIG. 2.

Example of the process of necrosis in the human bone. This is the thigh bone of a stump remaining after amputation of the knee.

- A. The old bone where it was sawn through in operation.
- BB. The old bone seen through the interstices of the new bone.
- cc. The new bone enclosing the old shaft.
- D. The head of the bone in a natural state.

The process here was similar to that in the experiment on the cock. The wound going wrong, a bad suppuration comes upon the stump, a wasting discharge comes from within the bone, the bone is inflamed ; the disease of the marrow proceeds, the bone dies, but not till new bone has been formed around the old.

During such a process, it is not wonderful that the continued irritation destroys the patient.

FIG. 3.

But sometimes it happens that after these injuries are sus-

tained, the old bone comes away as in this example ; and the stump may yet do well.

EXPLANATION OF PLATE III.

This plate illustrates the chapter on the formation of the teeth.

FIG. 1.

A tooth cut through and burnt.

- A. The enamel not affected by the heat.
- B. The body of the bone black.
- C. The canal of the tooth, in which solely the sensible nerve lies.

FIG. 2.

Shows the saccular pulp and rudiments of a tooth.

- A. The pulp of the form of the tooth hanging out of its proper place.
- B. The sac which contains the pulp and tooth, but being slit open they have fallen out of it.
- C. The shell of this bony part of the tooth which was formed on the pulp A ; but being a secretion from it, and not connected otherways with it, it has fallen off.

FIG. 3 and 4.

The rudiments of a bony part of a tooth, when beginning to form on the projecting parts of the pulp.

FIG. 5.

A common example of a ball found in the centre of an elephant's tooth.

- A. A part of the iron ball discovered.
- BB. Bone formed in circles round the tooth.
- C. The common matter of the tooth.
- D. Lesser nuclei of bone, marking the irregular action of secretion near the ball.

FIG. 6.

The bag containing the tooth and pulp, from the human subject.

- A. The bag, or sacculus.
- B. The lower part of the pulp, when it can be seen without opening the sac.

- c. The sac A contains the rudiments of the milk-tooth, and here appended is already the rudiments of the second tooth.

FIG. 7.

Section of the jaw of a child.

- A. The incisores of the first set of teeth.
B. C. D. E. The rudiments of the eye-tooth.
B. The pulp, having a connexion with the sacculus, and receiving arteries from the bone.
C. The soft pulp within the sac, and in *situ*.
D. The connexion of the sacculus with the gum.

The bone of the tooth forming.—And now it will be perceived how it increases: how successive layers of bone are deposited by the pulp beneath; and how, in due time, the enamel is deposited upon the bone of the tooth by the sac which surrounds it.

THE
ANATOMY
OF THE
BONES, MUSCLES, AND JOINTS.

BOOK I.
OF THE BONES.

CHAP. I.

OF THE FORMATION AND GROWTH OF BONES.*

IT is not easy to explain in their natural order, the various parts of which the human body is composed; for they have that mutual dependence upon each other, that continual circle of action and re-action in their various functions, and that intricacy of connection, and close dependence, in respect of the individual parts, that as in a circle there is no point of preference from which we should begin to trace its course, there is in the human body no function so insulated from the other functions, no part so independent of other parts, as to determine our choice. We cannot begin without hesitation, nor hope to proceed in any perfect course; yet, from whatever point we begin, we may so return to that point, as to represent truly this consent of functions, and connection of parts, by which it is composed into one perfect whole.

The bones are framed as a basis for the whole system, fitted to support, defend, and contain the more delicate and noble organs. They are the most permanent, unchangeable parts of all the body. We see them exposed to the seasons, without suffering the smallest change; remaining for ages the

* I have arranged the preparations illustrative of the growth and structure of bone, so as to correspond with this dissertation. They form the first series in the Gallery. C. B.

memorials of the dead ; the evidence of a former race of men exceeding ours in strength and stature ; the only remains of creatures which no longer exist ; the proofs of such changes on our globe, as we cannot trace but by these uncertain marks. Thus we are apt to conceive, that even in the living body, bones are hardly organized, scarcely partaking of life, not liable, like the soft parts, to disease and death. But minute anatomy, the most pleasing part of our science, unfolds and explains to us the internal structure of the bones ; shows their myriads of vessels, and proves them to be as full of blood as the most succulent and fleshy parts ; having, like them, their periods of growth and decay ; as liable to accidents, and as subject to internal disease.

The phenomena of fractured bones first suggested some indistinct notions of the way in which bone might be formed. It was observed, that in very aged men, a hard crust was often formed upon the surface of the bones ; that the fluid exuding into the joints of gouty people, sometimes coagulated into a chalky mass. Le Dran had seen in a case of *spina ventosa*, or scrophulous bone, an exudation which flowed out like wax, and hardened into perfect bone. Daventer had seen the juice exuding from a split in a bone, coagulate into a bony crust ; and they thought it particularly well ascertained, that callus was but a coagulable juice, which might be seen exuding directly from the broken ends, and which gradually coagulated into hard bone. The best physiologists did not scruple to believe, that bones, and the callus of broken bones, were formed of a bony juice, which was deposited by the vessels of the part, and which, passing through all the successive conditions of a thin uncoagulated juice, of a transparent cartilage, and of soft and flexible bone, became at last, by a slow coagulation, a firm, hard, and perfect bone, depending but little upon vessels or membranes, either for its generation or growth, or for nourishment in its perfect state. But this coagulation is a property of dead matter, which has no place in the living system ; or if blood or mucus do coagulate within the body, it is only after they are separated from the system. Coagulation is a sort of accident in the living body, and it is not to be believed that the accidental concurrence of parts should form the perfect system of a living bone ; nor that coagulation, an irregular, uncertain process, should keep pace with the growth of the living parts ; that a bone which is completely organized, and a regular part of the living system, should in all its progress towards this perfect state, be mere inanimate, inorganized matter : yet this opinion once prevailed ; and if other theories were at that time proposed, they did not vary in any very es-

sential point from this first notion. De Hide, a surgeon of Amsterdam, believed that bone or callus was not formed from a coagulable juice, but from the blood itself. He broke the bones of animals, and, examining them at various points of time, he never failed (like other speculators) to find exactly what he desired to find. In "every experiment," he found a great effusion of blood among the muscles, and round the broken bone ; and he as easily traced this blood through all the stages of its progress. In the first day red and fluid ; by and by coagulated ; then gradually becoming white, then cartilaginous, and at last (by the exhalation of its thinner parts) hardening into perfect bone.

It is very singular, that those who abjure theory, and appeal to experiments, who profess only to deliver facts, are least of all to be trusted ; for it is theory which brings them to try experiments, and then the form and order, and even the result of such experiments, must bend to meet the theories which they were designed to prove : it is by this deception that the authors of two rival doctrines arrive at opposite conclusions, by facts directly opposed to each other. Du Hamel believed, that as the bark formed the wood of a tree, adding, by a sort of secretion, successive layers to its growth, the periosteum* formed the bone at the first, renewed it when spoiled, or cut away, and, when broken, assumed the nature of bone, and repaired the breach. He broke the bones of pigeons, and, allowing them to heal, he found the periosteum to be the chief organ for re-producing bone. He found that the callus had no adhesion to the broken bone, was easily separated from the broken ends which remained rough and bare ; and, in pursuing these dissections, he found the periosteum fairly glued to the external surface of the new bone ; or he found rather the callus or regenerated bone to be but a mere thickening of the periosteum, its layers being separated, and its substance swelled. On the first days he found the periosteum thickened, inflamed, and easily divided into many lamellæ, or plates ; but while the periosteum was suffering these changes, the bone was in no degree changed. On the following days, he found the tumour of the periosteum increased at the place of the fracture, and extending further along the bone ; its internal surface already cartilaginous, and always tinged with a little blood, which came to it through the vessels of the marrow. He found the tumour of the periosteum spongy, and divisible into regular layers, while still the ends of the bone were unchanged, or only a little roughened by the first layer of the

* The periosteum is the membrane which surrounds and is attached to the surface of the bone, and which conveys the blood vessels to it.

periosteum being already converted into earth, and deposited upon the surface of the bone: and in the next stage of its progress, he found the periosteum firmly attached to the surface of the callous mass. By wounding, not breaking the bones, he had a more flattering appearance still of a proof; for, having pierced them with holes, he found the holes filled up with a sort of tompion, proceeding from the periosteum, which was thickened all round them. In an early stage, this plug could, by drawing the periosteum, be pulled out from its hole: in a more advanced stage, it was inseparably united to the bone so as to supply the loss.

Haller, doubting whether the periosteum, a thin and delicate membrane, could form so large a mass of bone or callus, repeated the proof, and he again found quite the reverse of all this: That the callus, or the original bone, were in no degree dependent on the periosteum, but were generated from the internal vessels of the bone itself: That the periosteum did indeed appear as early as the cartilage which is to produce the bone, seeming to bound the cartilage, and give it form; but that the periosteum was at first but a loose tissue of cellular substance, without the appearance of vessels, or any mark of blood, adhering chiefly to the heads or processes, while it hardly touched the body of the bone. He also found that the bone grew, became vascular, had a free circulation of red blood, and that then only the vessels of the periosteum began to carry red blood, or to adhere to the bone. We know that the bones begin to form in small nuclei, in the very centre of their cartilage, or in the very centre of the yet flexible callus, far from the surface, where they might be assisted by the periosteum.

Thus has the formation of bone been falsely attributed to a gelatinous effusion, gradually hardened; or to that blood which must be poured out from the ruptured vessels round the fractured bone; or to the induration and change of the periosteum, depositing layer after layer, till it completed the form of the bone.

But when, neglecting theory, we set ourselves to examine, with an unbiassed judgment, the process of nature in forming the bones, as in the chick, or in restoring them, as in broken limbs, a succession of phenomena present themselves, the most orderly, beautiful, and simple of any that are recorded in the philosophy of the animal body: for if bones were but condensed gluten, coagulated blood, or a mere deposition from the periosteum, they were then inorganized, and out of the system, not subject to change, nor open to disease; liable, indeed, to be broken, but without any means of being healed

again; while they are, in truth, as fully organized, as permeable to the blood, as easily hurt, and as easily healed, as sensible to pain,* and as regularly changed as the softest parts are. We are not to refer the generation and growth of bone to any other part. It is not formed by that jelly in which the bone is layed, nor by the blood which is circulating in it, nor by the periosteum which covers it, nor by the medullary membrane with which it is lined; but the whole system of the bone, of which these are parts only, is designed and planned, is laid out in the very elements of the body, and goes on to ripeness, by the concurring action of all its parts. The arteries, by a determined action, deposite the bone; which is formed commonly in a bed of cartilage, as the bones of the leg or arm are; sometimes betwixt two layers of membrane, like the bones of the skull, where true cartilage is never seen. Often the secretion of the bony matter is performed in a distinct bag, and there it grows into form, as in the teeth; for each tooth is formed in its little bag, which, by injection, can be filled and covered with vessels.† Any artery of the body may assume this action and deposite bone, which is formed also where it should not be, in the tendons, and in the joints, in the great arteries, and in their valves, in the flesh of the heart itself, or even in the soft and pulpy substance of the brain.‡

In the human fœtus, and in other animals, before the time of birth, instead of bones, there are only cartilages of the form of the future bone. The whole fœtus appears to the eye like a mere jelly: the bones are a pure, almost transparent, and tremulous jelly; they are flexible, so that a long bone can be bended into a complete ring; and no opacity nor spot of ossification is seen.

This cartilage never is hardened into bone; but, from the first, it is itself an organized mass. It has its vessels, which are at first transparent, but which soon dilate; and whenever the red colour of the blood begins to appear in them, ossification very quickly follows, the arteries being so far enlarged as to carry the coarser parts of the blood. The first mark of ossification is an artery, which is seen running into the centre of the jelly, in which the bone is to be formed. Other arteries soon appear, overtake the first, mix with it, and form a net work of vessels; then a centre of ossification begins, stretching its rays according to the length of the bone,

* The obscurity on this subject is from the neglect of defined terms. We shall presently see that the sensibility possessed by the bones, and the kind of pain to which they are subject, differs from the sensibility and pain of the skin and soft parts. C. B.

† The bone of the tooth is formed in a manner very different from common bone. C. B.

‡ The structure of the true and natural bone is different from the preternatural bony concretion in the vessels and membranes. C. B.

and then the cartilage begins to grow opaque, yellow, brittle, it will no longer bend, and the small nucleus of ossification is felt in the centre of the bone, and when touched with a sharp point, is easily known by its gritty feel. Other points of ossification are successively formed; always the ossification is foretold by the spreading of the artery, and by the arrival of red blood. Every point of ossification has its little arteries, and each ossifying nucleus has so little dependence on the cartilage in which it is formed, that it is held to it by vessels only; and when the ossifying cartilage is cut into thin slices, and steeped in water till its arteries rot, the nucleus of ossification drops spontaneously from the cartilage, leaving the cartilage like a ring, with a smooth and regular hole where the bone lay.

The colour of each part of a bone is proportioned exactly to the degree in which its ossification is advanced. When ossification begins in the centre of the bone, redness also appears, indicating the presence of those vessels by which the bony matter is to be poured out. When the bony matter begins to accumulate, the red colour of those arteries is obscured, the centre of the bone becomes yellow or white, and the colour removes towards the ends of the bone. In the centre, the first colouring of the bone is a cloudy, diffused, and general red, because the vessels are profuse. Beyond that, at the edges of the first circle, the vessels are more scattered and asunder, distinct trunks are easily seen, forming a circle of radiated arteries, which point towards the heads of the bone. Beyond that, again, the cartilage is transparent and pure, as yet untouched with blood; the arteries have not reached it, and its ossification is not begun. Thus, a long bone, while forming, seems to be divided into seven various coloured zones. The central point of most perfect ossification is yellow and opaque. On either side of that, there is a zone of red. On either side of that, again, the vessels being more sparse, form a vascular zone, and the zone at either end is transparent or white.* The ossification follows the vessels,

* It is curious to observe how completely vascular the bone of a chicken is before the ossification have fairly begun; how the ossification being begun, overtakes the arteries, and hides them, changing the transparent and vascular part of the bone into an opaque white; how, by peeling off the periosteum, bloody dots are seen, which show a living connection and commerce of vessels betwixt the periosteum and the bone; how by tearing up the outer layers of the tender bone, the vascularity of the inner layers is again exposed; and the most beautiful proof of all is that of our common preparations, where, by filling with injection the arteries of an adult bone, by its nutritious vessels, and then corroding the bone with mineral acids, we dissolve the earth, leaving nothing but the transparent jelly, which restores it to its original cartilaginous state; and then the vessels appear in such profusion, that the bone may be compared in vascularity with the soft parts, and it is seen that its arteries were not annihilated, but its high vascularity only concealed by the deposition of the bony part.

and buries and hides those vessels by which it is formed: The yellow and opaque part expands and spreads along the bone: The vessels advance towards the heads of the bones: The whole body of the bone becomes opaque, and there is left only a small vascular circle at either end; the heads are separated from the body of the bone by a thin cartilage, and the vessels of the centre, extending still towards the extremities of the bone, perforate that cartilage, pass into the head of the bone, and then its ossification also begins, and a small nucleus of ossification is formed in its centre. Thus the heads and the body are, at the first, distinct bones, formed apart, joined by a cartilage, and not united till the age of fifteen or twenty years.

The vessels are seen entering in one large trunk (the nutritious artery) into the middle of the bone: From that centre they extend in a radiated form towards either end, and the fibres of the bones are radiated in the same direction; there are furrows betwixt the rays, and the arteries run along in the furrows of the bone, as if the arteries were forming these ridges, secreting and pouring out the bony matter, each artery piling it up on either side to form its ridge.* The body of the bone is supplied by its own vessels; the heads of the bone are in part supplied by the extremities of the same trunks which perforate the dividing cartilage like a sieve; the periosteum adhering more firmly to the heads of the bone, brings assistant arteries from without, which meet the internal trunks, and assist the ossification; which, with every help, is not accomplished in many years.

It is by the action of the vessels that all the parts of the human body are formed, fluids and solids, each for its respective use: the blood is formed by the action of the vessels, and all the fluids are in their turn formed from the blood. We see in the chick, where there is no external source from which its red blood can be derived, that red blood is formed within its own system. Every animal system, as it grows, assimilates its food, and converts it to the animal nature, and so increases the quantity of its red blood: and as the red blood is thus prepared by the actions of the greater system, the actions of particular vessels prepare various parts; some to be added to the mass of solids, for the natural growth; others to supply the continual waste; others to be discharged from the body as effete and hurtful, or to allow new matter to be received: others again to perform certain offices within the body, as

* The arteries of a bone branch with freedom, and with the same seeming irregularity as in other parts of the body. The arteries do not exude their secretion from their sides, so as to pile up the ridge of bone in their course. The secretion seems to be performed in their very extremities. C. B.

semen, saliva, bile, or urine. Thus the body is furnished with various apparatus for performing various offices, and for repairing the waste. These are the secretions, and the formation of bone is one of these. The plan of the whole body lies in the embryo, in perfect order, with all its forms and parts. Cartilage is laid in the place of bone, and preserves its form for the future bone, with all its apparatus of surrounding membranes, its heads, its processes, and its connection with the soft parts. The colourless arteries of this pellucid but organized mass of cartilage keep it in growth, extend, and yet preserve its form, and gradually enlarging in their own diameter, at last receive the entire blood.* Then the deposition of earthy matter begins. The bone is deposited in specks, which spread and meet and form themselves into perfect bone. While the bone is laid by arteries, the cartilage is conveyed away by the absorbing vessels; and while they convey away the superfluous cartilage, they model the bone into its due form, shape out its cavities, cancelli, and holes, remove the thinner parts of the cartilage, and harden it into due consistence.

If such organization of arteries to deposite bone, and absorbents to take up the cartilage, and make room for the osseous matter, be necessary in the formation and growth, it is no less necessary for the life and health of the full formed bone. Its health depends on the regular deposition and re-absorption, moulding and forming the parts; and by various degrees of action, bone is liable to inflame, ulcerate, to rot and spoil, to become brittle by too much secreted earth, or to become soft by a greedy diseased absorption of its earthy parts. The earth, which constitutes the hardness, and all the useful properties of bone, is dead, inorganized, and lies in the interstices of the bone, where it is made up with mucus, to give it consistence and strength; furnished with absorbents to keep it in health, and carry off its wasted parts; and pervaded by vessels to supply it with new matter. The cartilage is in itself a secretion, to which the full secretion of bone succeeds, as the arteries grow stronger in their secreting office: for in a broken limb there is first a thin effusion, then a tremulous jelly, then radiated vessels, then ossifying spots, and these

* Previous to the formation of bone (or the preparation of it) in the cartilage, there is no proof of there being vessels in it. But we presume that the cartilage must have vessels, because it grows with the growth of the animal, previous to the formation of bone in it.

However, the change, previous to the deposition of bone, has not been noticed: the firm cartilage suffers a change; there is a tract from the circumference to the centre of it, in which the firm cartilage is dissolved; and in the spot where the first particle of bone is to be deposited, there is a little soft well of matter, different from the firm substance of the cartilage. C. B.

running together, form a perfect bone.* If the broken limb be too much moved during the cure, then are the secreting arteries interrupted in their office, perfect bone is never formed, it remains a cartilage, and an unnatural joint is produced; the vessels are opened again, the process is renewed, and the bones unite; or even by rubbing, by stimulating, by merely cutting the surrounding parts, the vessels are made active, and their secretion is renewed. During all the process of ossification, the absorbents proportion their action to the stimulus which is applied to them; they carry away the serous fluid, when jelly is to take its place; they remove the jelly, as the bone is laid; they continue removing the bony particles also, which (as in a circle) the arteries continually renew.

Nothing can be more curious than this continual renovation and change of parts, even in the hardest bones. We are accustomed to say of the whole body, that it is daily changed; that the older particles are removed, and new ones supply their place; that the body is not now the same individual body that it was; but it could not be easily believed that we speak only by guess concerning the softer parts, what we know for certain of the bones. It was discovered by chance that animals fed upon the refuse of the dyer's vats, received so much of the colouring matter into the system, that the bones were tinged by the madder to a deep red, while the softer parts were unchanged; no tint remaining in the ligaments nor cartilages, membranes, vessels, nor nerves, not even in the delicate vessels of the eye. It was easy to distinguish by the microscope, that such colour was mixed with the bony matter, resided in the interstices only, but did not remain in the vessels of the bone, which, like those of all the body, had no tinge of red; while our injections again fill the vessels of the bone, make all their branches red, but do not affect the colours of the bony part. When madder is given to animals, withheld for some time, and then given again, the colour appears in their bones, is removed, and appears again with such a sudden change as proves a rapidity of deposition and absorption, exceeding all likelihood or belief. All the bones are tinged in twenty-four hours; in two or three days their colour is very deep; and if the madder be left off but for a few days, the red colour is entirely removed.

* The matter may be thus stated: the extravasated blood being absorbed, an effusion is poured out by the vessels of the broken bone. This matter is a regular secretion, it appears to the eye like a uniform jelly; but so does the embryo itself. It is bone in embryo, the membranes and vessels, arteries, veins, and absorbents are in it; the arteries of the surrounding parts do not shoot into it, but veins, as well as arteries and absorbents, inosculate with the vessels of this new formed matter; and whatever vessels may, by accidental contact, inosculate with this substance, whether coming from bone, muscles, or membrane, still bone is formed, because it is the destined constitution of the new formed bone, or rather of the vessels which are already in it to form bone. C. B.

This tinging of the bones with madder, was the great instrument in the hands of Du Hamel, for proving by demonstration that it was by layers from the periosteum that the bone was formed; and how very far the mind is vitiated by this vanity of establishing a doctrine on facts, is too easily seen here. Du Hamel, believing that the periosteum deposited successive layers, which were added to the bone, it was his business to prove that the successive layers would be deposited alternately red, white, and red again, by giving a young animal madder, withholding it for a little while, and then beginning again to give it. Now, it is easy to foresee that this tinging of the lamellæ should correspond with the successive times in which the periosteum is able to deposite the layers of its substance, but Du Hamel very thoughtlessly makes his layers correspond only with the weeks or months in which his madder was given or withheld. It is easy to foresee also, that if madder be removed from the bones in a few days, (which he himself has often told us,) then his first layer, viz. of red bone, could not have waited for his layer of white to be laid above it, nor for a layer of red above that again, so that he should have been able to show successive layers: And if madder can so penetrate as to tinge all the bones that are already formed, then, though there might be first a tinged bone, then a white and colourless layer, whenever he proceeded to give madder for tinging a third layer, it would pervade all the bone, tinge the layer below, and reduce the whole into one tint. If a bone should increase by layers, thick enough to be visible, and of a distinct tint, and such layers be continually accumulated upon each other every week, what kind of a bone should this grow to? Yet such is the fascinating nature of a theory, that Du Hamel, unmindful of any interruptions like those, describes boldly his successive layers, carrying us through regular details, experiment after experiment, till at last he brings up his report to the amount of five successive layers, viz. two red layers, and three white ones. And in one experiment he makes the tinge of the madder continue in the bones for six months, forming successive layers of red and white, although in an earlier experiment (which he must have forgotten in his hurry) he tells us, that by looking through the transparent part of a cock's wing, he had seen the tinge of the madder gradually leave the bones in not many days.

These experiments are as gross and palpable as the occasion of them, and should stand as a warning to us, showing how severely and honestly we must question our own judgment, when trying to confirm our preconceived theories by experiments and facts.*

* However just this criticism is upon the reasoning of Du Hamel, yet I believe in the facts stated. In my Collection may be seen the bone of a pig showing three distinct layers, distinguishable in colour. C. B.

Yet, by these experiments with madder, one most important fact is proved to us; that the arteries and absorbents, acting in concert, alternately deposite and re-absorb the earthy particles, as fast as can be conceived, of the soft parts, or even of the most moveable and fluctuating humours of the body. The absorption of the hardest bones is proved by daily observation; when a carious bone disappears before the integuments are opened; when a tumour, pressing upon a bone, destroys it; when an aneurism of the temporal artery destroys the skull; when an aneurism of the heart beats open the thorax, destroying the sternum and ribs; when an aneurism of the ham destroys the thigh-bone, tibia, and joint of the knee; when a tumour coming from within the head, forces its way through the bones of the skull;—in all these cases, since the bone cannot be annihilated, what can happen, but that it must be absorbed and conveyed away? If we should need any stronger proofs than these, we have molities ossium, a disease by which, in a few months, the bony system is entirely broken up, and conveyed away, by a high action of the absorbents, with continual and deep-seated pain; a discharge of the earthy matter by the urine; a gradual softening of the bones, so that they bend under the weight of the body; the heels are turned up behind the head; the spine is crooked; the pelvis distorted; the breast crushed and bent in; and the functions beginning to fall low, the patient, after a slow hectic fever, long and much suffering of pain and misery, expires, with all the bones distorted in a shocking degree, gelatinous, or nearly so, robbed of all their earthy parts, and so thoroughly softened as to be cut with the knife.*

Thus, every bone has, like the soft parts, its arteries, veins, and absorbent vessels; and every bone has its nerves too. We see them entering into its substance in small threads, as on the surfaces of the frontal and parietal bones: We see them entering for particular purposes, by a large and peculiar hole, as the nerves which go into the jaws to reach the teeth: We find delicate nerves going into each bone along with its nutritious vessels; and yet we dare hardly believe the demonstration, since bones seem quite insensible and dead: We have no pain when the periosteum is rasped and scraped from a bone: We have no feeling when bones are cut in amputation; or when, in a broken limb, we cut off with pincers, the protruding end of a bone; We feel no pain when a bone is trepanned, or when caustics are applied to it; and it has been always known, that the heated irons which the old surgeons

* See the examples of distortion in the Museum, Windmill Street, and in particular the skeleton of a woman who died in consequence of the Cæsarean operation. C. B.

used so much, made no other impression than to excite a particular titillation and heat, rather pleasant than painful, running along the course of the bone. But there is a deception in all this. A bone may be exquisitely sensible, and yet give no pain; a paradox which is very easily explained. A bone may feel acutely and yet not send its sensation to the brain. It is not fit that parts should feel in this sense, which are so continually exposed to shocks and blows, and all the accidents of life; which have to suffer all the motions which the other parts require. In this sense, the bones, the cartilages, ligaments, bursæ, and all the parts that relate to joints, are quite insensible and dead. A bone does not feel, or its feelings are not conveyed to the brain: but, except in the absence of pain, it shows every mark of life. Scrape a bone and its vessels bleed; cut or bore a bone, and its granulations sprout up; break a bone, and it will heal; or cut a piece of it away, and more bone will readily be produced; hurt it any way, and it inflames; burn it, and it dies: take any proof of sensibility, but the mere feeling of pain, and it will answer to the proof. In short, these parts have a sensibility which belongs to themselves, but have no feelings in correspondence with the general system.*

A bone feels stimuli, and is excited to re-act; injuries produce inflammation in the bones, as in the soft parts; and then swelling and spongy looseness, and a fulness of blood, suppuration, ulcer, and the death and discharge of the diseased bone ensue. When the texture of a bone is thus loosened by inflammation, its feeling is roused; and the hidden sensibility of the bone rises up like a new property of its nature: and as the eye, the skin, and all feeling parts have their sensibility increased by disease, the bones, ligaments, bursæ, and all the

* From the consideration of these facts, together with this most essential one, viz. that bones, ligaments, and tendons are actually capable of receiving and propagating painful impressions to the sensorium, I have come to the following conclusion:—The sensation of pain is bestowed as a safeguard to the frame, forcing us to avoid whatever is hurtful. To this effect, sensibility varies in different parts, and in general the sensibility of the more superficial parts, being sufficient protection to the parts beneath, the deep parts are but little sensible. The sensibility possessed by the skin would not be sufficient protection to the eye; such parts differ in kind of sensibility as well as in degree. Experiments have been made by cutting and burning the bones and tendons, and the conclusion has been, that they were insensible. But when a man sprains his ankle-joint, he is in extreme pain, though he can easily satisfy himself that the pain he feels is not in the skin, but must be in the joint and tendons. It appears then, that such parts usually thought insensible, feel pain and can propagate that pain to the sensorium; and further, that the peculiar sensibilities are so suited as to allow of the free and natural motion and of the necessary degree of attrition, but are bestowed for the purpose of making us avoid that degree of violence, which would endanger the texture or healthy function of the part. C. B.

parts whose feeling during health, is obscure and hardly known, are roused to a degree of sensibility far surpassing the soft parts. The wound of a joint is indeed less painful at first, but when the inflammation comes, its sensibility is raised to a dreadful degree: the patient cries out with anguish. No pains are equal to those which belong to the bones and joints.

This ossification is a process of a truly animal nature: no coagulation will harden cartilage into bone; no change of consistence will form the blood into it; no condensation of the periosteum can assimilate it to the nature of a bone. Bone is not the inorganic concrete which it was once supposed, but is a regularly organized part, whose form subsists from the first, which is perfected by its secreting arteries, balanced, as in every secretion, by the absorbents of the part; it lives, grows, and feels, is liable to accidents, and subject to disease. Ossification is a process which, at first, appears so rapid, that we should expect it to be soon complete; but it becomes in the end a slow and difficult process. It is rapid at first; it advances slowly after birth; it is not completed till the twentieth year; it is forwarded by health and strength, retarded by weakness and disease. In scrophula it is imperfect; and so children become rickety, when the bones soften and swell at their heads, and bend under the weight of the body. And why should we be surprised, that carelessness of food or clothing, bad air, or languid health, should cause that dreadful disease, when more or less heat, during the incubation of a chick, prevents the growth of its bones; when the sickness of a creature, during our experiments, protracts the growth of callus; when, in the accidents of pregnancy, of profuse suppuration, or of languid health, the knitting of broken bones is delayed, or prevented quite?

This process, so difficult and slow, is assisted by every provision of nature. The progress of the whole is slow, that so long as the body increases in stature, the bones also may grow; but it is assisted in the individual parts, where some are slow, some rapid in their growth, some delayed, as the heads of joints, that their bones may be allowed to extend, and others hastened, as the pelvis, that it may acquire its perfect size early in life. Ossification is assisted by the softness of the cartilaginous bed in which the bone is formed; by those large and permeable vessels which carry easily the grosser parts of the blood; by a quick and powerful absorption, which all along is modelling the bone; and, most of all, by being formed in detached points, multiplied and crowded together, wherever much bone is required.

There is one central ring first ossified in a long bone, as of

the leg or arm; the heads or ends of the bone are at first mere cartilage, but they also soon begin to ossify; the body stretches in a radiated form towards either head; the heads ossifying each in its centre, also stretch towards the bone; the heads meet the body, and join to it; a thin cartilage only is interposed, which grows gradually thinner till the twentieth year, and then disappears, the body, heads, and processes, becoming one bone. In flat bones,* as in the skull, ossification goes from one or more central points, and the radiated fibres meet the radii of other ossifying points, or meet the edges of the next bone. See plate I. fig. 3 and 4. The thick round bones which form the wrist and foot, have one ossification in their centre, which is bounded by cartilage all round. The processes are often distinct ossifications joined to the bones, like their heads, and slowly consolidated with them into firm bones.†

While the bone is forming, various parts, essential to its system, gradually rise into view. At first we cannot in the long bone perceive any heads, processes, cavities, or cells; these parts are very slowly formed, and are perfected only in the adult bone.

At first, the whole length of a long bone is represented by a transparent jelly, where there is no distinction of heads nor processes; it is all of one mass. After the red blood has begun to tinge this cartilage, the ossification begins, and one ring is formed in the middle of the bone: from this ring the

* The ossification of the flat bones is a subject too curious to be omitted in this dissertation. The brain of the fetus while of the size of a hazel-nut is invested with a membrane in which there is as yet no speck of bone. In the third month, the ossification of the cranial bones commence, and the first process exhibits a very beautiful net of ossific wire-work. In a circle, the diameter of which is half an inch, we see a perfect net-work, resembling a fine lace or the meshes of a spider's web. Upon this first layer another is deposited, and this superimposed net-work of bone is finer than the first; the meshes being smaller and the bony matter more abundant. The holes of the second net are not opposite to those of the first, so that the eye no longer penetrates the bone, although the structure be quite light and porous. While the second and third layer of bone is deposited on the outside of the first, the inner layer is extending in threads diverging from the centre, betwixt which delicate processes of bone, intervening ribs are formed irregularly, still resembling the texture of the spider's web; and the diverging line of bone being the stronger, it appears as if the cranial bones formed in diverging radii, while the edge of the bone extends in fine net-work, like to the first formed speck of ossification.

It is further worthy of remark, that this is the texture of true bone, and that what are called morbid ossifications, as of the coats of arteries and other membranes are merely the deposite of earthy matter without organic structure. C B.

† The processes and heads are named the epiphysis and apophysis of bones. The apophysis, a process which projects from the bone and grows from it. The epiphysis is that portion which growing by a distinct centre of ossification is afterwards united to the body of the bone. C B.

fibres stretch towards either end, and stop there (fig. 1. plate I.); then it begins to appear that the heads and body are distinct parts; the fibres of the growing bone have extended till the cartilage is annihilated, and only a small plate remains, separating the knobs of the heads from the long body of the bone. Thus there is no distinction betwixt the heads and the body, while the heads are cartiliginous; they begin to appear, as distinct parts, at that stage in which the body of the bone is ossified, and each of the heads is beginning to form; they continue three distinct bones, during all the early part of life, and are easily separated, by soaking the bone in water; when they are separated, there is seen a rough hollow, on the surface of the epiphysis, or separated head, and a rough convexity on the end of the body: they are finally united into one bone, about the twentieth year.

In the original cartilage, there is no hollow nor cavity; it is all one solid mass. Fig. 1. plate II. When the ossification first appears, the cavity of the bone also begins, and extends with the ossification: at first the cavity is confined chiefly to the middle of the bone, and extends very slowly towards the ends. This cavity, in the centre of the bone, is at first smooth, covered with an internal membrane, containing the trunks and branchings of the nutritious vessels, which enter by a great hole, in the middle of the bone; and the cavity is traversed, with divisions of its lining membrane, which, like a net-work of partitions, conduct its branches to all parts of the internal surface of the bone; and its nets, or meshes, are filled with a reddish and serous fluid in the young bone, but secrete and contain a perfect marrow in the adult bone.

The whole substance of a bone is not only fibrous, as appears outwardly, but is truly lamellated, consisting of many distinct and delicate plates of bone, which lie over each other, in regular order, and might suggest the notion of successive ossifications of the periosteum forming the bone. These lamellæ, or plates, are more condensed and firm, towards the outer surface, and are more loose, separate and spongy, towards the internal surface of the bone; and it is easily seen, during the growth of a young bone, that the inner and more delicate plates are separating from the walls of the bone, and receding towards its cavity: and these plates, being again crossed by small bony partitions, form a net-work, or spongy mass, which fills the whole cavity of the bone. In the middle of the bone, the cavity is small, the walls thick, and having all their bony plates; the cells of net-work few, and large; but towards the ends, the bone swells out, the cavity also is large; but it is not like that in the middle, a large tabular

cavity: it is so crossed with lattice-work, with small interstices and cells, that it seems all one spongy mass of bone; and so many of the inner layers are separated, to form this profusion of cells, that the whole substance of the bone has degenerated into this lattice-work, leaving only a thin outward shell.* This reticular form is what anatomists call the cancelli, lattice-work, net-work, or alveolar part of the bone: it is all lined with one delicate membrane, and inward partitions of the same lining membrane cover each division of the lattice-work, forming each cell into a distinct cavity. In these cavities, or cells, the marrow is secreted. The secretion is thin and bloody in children; it thickens as we advance in years; it is a dense oil, or marrow in the adult. The marrow is firmer, and more perfect in the middle of the bone, and more thin and serous towards the spongy ends. The whole mass, when shaken out of the bone, is like a bunch of grapes, each hanging by its stalk. The globules, when seen with the microscope, are neat, round, and white, resembling small pearls, and each stalk is seen to be a small artery, which comes along the membrane of the cancelli, spreads its branches beautifully on the surface of the bag, and serves to secrete the marrow, each small twig of artery filling its peculiar cell. To this, an old anatomist added, that they had their contractile power, like the urinary bladder, for expelling their contents; that they squeezed their marrow, by channels of communication, through and among the bony layers; and that their oil exuded into the joint, by nearly the same mechanism, by which it got into the substance of the bone.

While the constitution of a bone was not at all understood, anatomists noted with particular care every trifling peculiarity in the forms or connections of its parts, and these lamellæ attracted particular notice. That a bone is formed in successive plates, is easily seen, as in whalebone; or in the horns and bones of the larger animals; in church-yard bones, which have been long buried, or long exposed to the air. It is demonstrated by a careful picking, and separation of the scales in a young bone, or by burning a bone, which melts and consumes its jelly, and leaves the bony parts entire. It is seen in the common diseases of bones; for they cast off by successive plates or leaves, whence the process is named exfoliation; and one plate is thoroughly spoiled and cast off,

* That it is merely an expansion of the layers which forms the cancelli, and a mere swelling and sponginess of the same quantity of bony substance, which makes the ends so much thicker than the middle, is proved by this, that an inch of the smaller bony tube, cut from the middle, weighs equally with an inch of the large spongy tube, cut out from the ends.

while another is entire and sound. Malpighi had first observed the lamellated structure of bones, likening them to the leaves of a book. Gagliardi, who, like Hippocrates, went among the burial places of the city, to observe the bones there, found in a tomb, where the bones had been long exposed, a skull, the os frontis of which he could dissect into many layers, with the point of a pin.* He afterwards found various bones, from all parts of the body, thus decomposed; and he added to the doctrine of plates, that they were held together by minute processes, which, going from plate to plate, performed the offices of nails: these appeared to his imagination to be of four kinds, straight and inclined nails, crooked or hook-like, and some with small round heads, of the forms of bolts or pins.†

Another notable discovery, was the use of the holes which are very easily seen through the substance of bones, and among their plates. They are, indeed, no more than the ways by which the vessels pass into the bones: but the older anatomists imagined them to be still more important, allowing the matter to transude through all the substance of the bone, and keep it soft. Now this notion of lubricating the earthy parts of a bone, like the common talk of fomentations to the internal parts of the body is very mechanical, and very ignorant; for the external parts of the body are both hot and moist of themselves, and neither heat nor moisture can reach them from without: the bone is already fully watered with arteries; it is moist in itself, and cannot be further moistened nor lubricated, unless by a fuller and quicker circulation of its blood. It must be preserved by that moisture only which exists in its substance, and must depend for its consistence upon its own constitution; upon the due mixing up of its gluten and earth. Every part is preserved in its due consistence by the vessels which form its subsistence; and I should no more suppose fat necessary for preserving the moistness of a bone, than for preventing brittleness

* Notwithstanding what is here delivered, there is no proof of the bones being lamellated; as to the exfoliation of bone, the dead portion is more generally irregular in its thickness, and rugged on its inner surface. This exfoliation of bone is a process of the living bone, and the inner living surface recedes from the outer one, because that outer surface is injured or dead. The nature of the injury, or the depth to which the bone has become dead, determines the extent and form of the portion cast off. When a scale only is thrown off, it is because the bone is only dead upon the surface. In regard to the breaking up of the surface of the cranial bones, when they lie exposed, the scales are similar to those from stones or metals exposed to the influence of the air, and moisture, and varying temperature: the thickness and succession of exfoliations depends on the operation of the weather, not on the original formation of the bone. I have never seen heat produce a lamellated decomposition of bone. C. B.

† These nails Gagliardi imagined were no more than the little irregularities, risings, and hollows of the adjoining plates, by which they are connected.

in the eye. This marrow is, perhaps, more an accidental deposition than we, at first sight, believe. We indeed find in it such a regularity of structure, as seems to indicate some very particular use; but we find the same structure exactly in the common fat of the body. When, as we advance in years, more fat is deposited in the omentum, or round the heart, we cannot entertain the absurd notion, of fat being needed in our old age, to lubricate the bowels or the heart; no more is the marrow (which is not found in the child,) accumulated in old age, for preventing brittleness of the bones.*

The blood vessels of a bone are large, in proportion to the mass of the bone. For first one great trunk enters commonly about the middle of the bone, as in the thigh bone, leg or arm, and it is called the nutritious or medullary artery: it goes in the central cavity of the bone, spreads upwards and downwards, supplies all the substance of the bone itself, and gives those delicate arteries which secrete the marrow. Other arteries enter from without at the spongy ends of the bones, where the bones are not visible only, but very large in the adult; particularly large arteries enter into the heads of the holes, as of the shoulder or of the thigh bones; and there the periosteum adheres very strongly; and every where on its surface the bone is supplied by numerous vessels from the periosteum (and this seems indeed to be the chief use of that membrane;) so that in tearing off the periosteum, the surface of the membrane, and of the bone, are seen covered with bloody points; all the vessels are conducted to the substance of the bone by its two membranes: the internal vessels by the membrane which lines the cavity, and which is known by the absurd name of internal periosteum; the external one by the outer membrane, the proper or external periosteum.

The internal periosteum is that membrane which surrounds the marrow, and in the bags of which the marrow is formed and contained. It is more connected with the fat than with the bone; and in animals, can be drawn out entire from the cavity of the bone; but its chief use is to conduct the vessels which are to enter into the substance of the bone; and this connexion and office is so essential to the life and health of the bone, that the spina ventosa, or scrophulous bone, is merely a

* If we look to the difference there is in the adipose membrane, we shall find it more apparent than real. The fat on the soles of the feet and palms of the hands is particularly firm, but this firmness results from the strong intertexture of filaments of a tendinous strength. The fat in the exposed parts of the limbs is less firm, in the orbits of the eyes more delicate, but in the bones it lies in transparent membranes, and is quite soft and compressible. The difference, however, is only in the manner in which the bags containing the fat are bound up and protected; where the substance is exposed to pressure, it is firm, where it lies concealed, it is less so; but where it is altogether within the protection of the bones, the membranes are very delicate, and the fat takes the appearance of marrow. C. B.

failure of the internal circulation, a total corruption of the marrow, and a consequent loss of the medullary vessels ; by which the whole bone dies, is thrown out by nature, or oftener the limb must be cut off.* The same effect is produced in our experiments, where, by piercing into the medullary cavity, and destroying the marrow, the shaft of the bone dies, while the heads and processes live, only because they are supplied more fully by their external vessels.

The periosteum, which was once referred to the dura mater, is merely condensed cellular substance ; of which kind of matter we now trace many varied forms and uses, for so close is the connexion of the periosteum, tendons, ligaments, fasciæ, and bursæ, and so much are these parts alike in their nature and properties, that we reckon them but as varied forms of one common substance, serving for various uses in different parts. The periosteum consists of many layers, accumulated and condensed one above another : it adheres to the body of the bone by small points or processes, which dive into the substance of the outer layer, giving a firm adhesion to it, so as to bear the pulling of the great tendons, which are fixed rather into the periosteum than into the bone. It is also connected with the bone by innumerable vessels. The layers of the periosteum nearest to the bone are condensed and strong, and take a strong adhesion to the bone, that the vessels may be transmitted safe, and the fibres of this inner layer follow the longitudinal directions of the bony fibres. The periosteum is looser in its texture outwardly, where it is reticulated and lax, changing imperceptibly into the common cellular substance. There the fibres of the periosteum assume the directions of the muscles, tendons, or other parts which run over it. The periosteum is not for generating bone ; and therefore it adheres but slightly to the growing bone : it is for nourishing the external plates ; and therefore, as the bone grows, and as the external plates are further removed from the medullary vessels, the adhesion of the periosteum becomes closer, its arteries are enlarged, and the dependence of the outer layers on the periosteum is as well proved as the dependence of the body of the bone upon its medullary artery ; for as piercing the medulla kills the whole bone, hurting the periosteum kills the outer layers of the bone. Any accident which spoils the bone of its periosteum has this effect ; the accidental wounds of the periosteum, deep ulcers of the soft parts, as on the shin, the beating of aneurisms, the growth of tumours, the pressure even of

* This disease is rather what we call *necrosis*, in which the bone dies. The *spina ventosa* is the consequence of abscess in the cavity of the bone. See the specimens in my collection. C. B.

any external body, will, by hurting the periosteum, cause exfoliation, which is, in plain terms, the death of the external layer, by the injury of the outward vessels; and an active inflammation of the deeper layers, which being fully nourished by the internal arteries, inflame, swell, become porous and spongy, form granulations, and these granulations push off the mortified plate, and form themselves into new bone, which supplies its place.*

The cartilages are also a part of the living system of the bone; and we see too well, in the question of the bones themselves, how unphilosophical it must be to deny organization and feeling to any part of the living body, however dead or insulated it may appear; for every part has its degree of life: the eye, the skin, the flesh, the tendons, and the bones, have successive degrees of feeling and circulation. We see, that where even the lowest of these, the bone, is deprived of its small portion of life, it becomes a foreign body, and is thrown off from the healthy parts, as a gangrened limb is separated from the sound body; and we speak as familiarly of the death of a bone, as of the gangrene of soft parts. How, then, should we deny organization and life to the cartilages? though surely, in respect of feeling, they must stand in the very last degree.

The periosteum goes from the bone over the surface of the cartilage also, where it is named perichondrium: It still preserves its own vascular nature: the vessels can be injected; and it is not to be believed that the perichondrium has these vessels, without communicating them to the cartilage to which it belongs. We see red arteries in the centre of an ossifying cartilage, and therefore we know that the trunk of the artery may be red, as in the ossifying part of the cartilage, and yet the extremity of the same artery be pellucid, as in the unossified part. Since vessels run through the cartilage to generate bone, we cannot in reason, suppose that these vessels are produced in the instant in which they appear: they had existed before; they are but dilated now; the increasing action dilates them, and the dilatation makes them red: this enables them to secrete bone, and, in many cases, as in the accidental joint formed by a fracture ill cared for, we can, by paring the cartilage, set the vessels free again, and make them begin to secrete.†

* It is the injury to the surface of the bone which causes the exfoliation, not the loss of vessels by the separation of the periosteum; and when the bone dies, as in necrosis, from the injury to the marrow, inflammation precedes the death. C. B.

† This is true as a physiological fact, but it is not the proper method of curing this defect of union in a bone. See the 2d vol. of Operative Surgery by C. Bell.

Wherever we find a vascular membrane surrounding and nourishing any part, as the vitreous or crystalline humours in the eye, we must not suppose that such are insulated parts, maintained there by mere adhesion; but must consider them as parts regularly organized, their vascular membrane being part of their living system; and though the transparent humours of the eye, the cartilages and ligaments over all the body, and all the system of the bones, have been considered as mere concretes, and insulated parts, they are now known to be regular parts of the living whole. The cartilages have no very active circulation; it is such as to keep them in life, but not so active as to endanger inflammation, in the continual shocks which they must endure; their feeling must be very obscure, for feeling also would have been inconsistent with their offices, which is to cover and defend the bones; to yield to the weight of the body, and to restore themselves when that weight is removed; to bear all the shocks of leaps or falls; to perform all the motions of the body, and the continual workings of the joints, where they rub, and even crackle upon each other without danger or pain.

We now understand the constitution of a bone, and can compare it fairly with the soft parts in vascularity, and in feeling; in quickness of absorption; in the regular supply of blood necessary to the life of the bony system; in the certain death of a bone, when deprived of blood by any injury of its marrow, or of its periosteum, as a limb dies of gangrene, when its arteries are cut or tied; in the continual action of its absorbents, forming its cavity, shaping its processes and heads, keeping it sound and in good health, and regulating the degree of bony matter, that the composition may neither be too brittle nor too soft. From this constitution of a bone, we could easily foresee how the callus for uniting broken bones must be formed; not by a mere coagulation of extravasated juice, but by a new organization resembling the original bone.

The primordium of all the parts of the body is a thin gelatinous mucus, in which the forms of the parts are laid; and the preparation for healing wounds, and for every new part that needs to be formed, is a secretion of mucus which is soon animated by vessels coming into it from every point. In every external wound, in every internal inflammation, wherever external parts are to be healed, or internal viscera are about to adhere, a mucous matter is secreted, which serves as a bed or nidus, in which the vessels spread from point to point, till the mucus is animalized and converted into a membrane: and thus the heart, the intestines, the testicle, and other parts, adhere by inflammation to the coats which surround them, and

which are naturally loose. It is a mucus of the same form which unites the ends of a broken bone ; and, by breaking the bones of animals, and attending to the progress of the callus, we find first a thin mucus ; then that thickened into a transparent jelly ; that jelly growing vascular, and these vessels gradually depositing nuclei of ossification in the centre of the mass ; and by madder or by fine injections, we can make the jelly appear vascular, and make the nuclei of ossification quite red. The colours of our injections begin to tinge the cartilage as it begins to ossify, and as soon as the ossification is general, it receives a general tinge.

When we find the substance of the oldest bone thus full of vessels, why should we doubt its being able, from its own peculiar vessels, to heal a breach, or to repair any loss ? We have no reason to refer the generation of callus to the marrow, to the periosteum, nor to the substance of the bone itself, for they are but parts of the common system of a bone ; and each part of this system is of itself capable of regenerating the whole. How little the constitution of a bone has been understood, we may know from the strange debates which have subsisted so long about the proper organ for generating callus. Some have pronounced it to be the periosteum ; others, the medullary vessel, and internal membrane ; others, the substance of the bone itself : but I have been employed in explaining, that not only part of the bone, periosteum, or marrow, but even any artery in all the system, may assume that action which generates bone. In the heat of this dispute, one of the most eminent anatomists produced a diseased bone, where a new bone was formed surrounding a carious one, and the spoiled bone rattled within the cavity of the sound one : here we should have been ready to pronounce, that bone could be formed by the periosteum only. But presently another anatomist produced the very reverse, viz. a sound young bone, forming in the hollow cylinder of a bone which had been long dead ; where of course, the callous matter must have been poured into the empty cavity of the spoiled bone, from the ends which still remain sound, or must have been secreted by the medullary vessels. But the truth is, that callus may be thus produced from any part of the system of a bone ; from its periosteum, from its medulla, or from the substance of the bone itself.* If we pierce the bone of any animal, and de-

* The term, system of a bone, is incorrect, if by it is meant the periosteum which surrounds the bone, and the marrow within. In the experiments and observations which I have made, neither the periosteum or marrow seemed to have formed the bone ; and I conclude, that nothing but bone can form bone, by the continuation of natural actions ; and that in the case of *necrosis*, the old bone inflames and begins the new formation, before the continued irritation in the centre kills it. C. B.

stroy the marrow, the old bone dies, and a new one is formed from the periosteum : if we kill the creature early we find the new bone to be a mere secretion from the inner surface of the periosteum ; and if we wait the completion of the process, we find the new bone beautiful, white, easily injected, and thick, loose in its texture, and vascular and bloody, but still firm enough for the animal to walk upon ; and in the heart of it, we find the old bone dead and black. If we reverse this operation, and destroy the periosteum only, leaving the nutritious vessels entire, then the new bone is formed fresh and vascular by the medullary vessels, and the old one quite black and dead, surrounds it ;* and in fractures of the patella or kneecap, where there are no medullary vessels, the pieces are united by a callus, which is secreted from the vessels of the bone itself.

The diseases of the bones are the most frequent in surgery ; and it is impossible to express how much the surgeon is concerned in obtaining true ideas of the structure, constitution, and diseases of bones ; how tedious, how painful, and how loathsome they are ; how often the patient must lose his limb, or endanger his life ; how very useful art is ; but above all what wonders nature daily performs in recovering bones from their diseased state.

* When I injure the marrow of the bone, necrosis is the consequence, see plate III. fig. 1. When I divide the bone, of its periosteum and surround it with a bit of bladder, I find the whole surface exfoliates, and the cavity of the bone fills up ; but this is not a consequence of the destruction of the vessels of the periosteum, but of the contact of foreign matter with the surface of the bone. An effect precisely similar is the consequence of the sloughing of the soft parts over a bone, for the dead slough lying on the surface of the bone causes an exfoliation.

The effect of injury to a living bone is very curious. But the manner in which the bone resumes its pristine form is still more worthy of observation. At first the outward exfoliation is attended with a proportionate filling up of the cavity of the bone. And the injury to the centre and body of the bone produces a new bone around the old one, and the old one at last dies and is absorbed or discharged. But after years these changes are again reversed, and the new bone contracts its diameter, and the cavity becomes of its natural dimensions so that the evidence of the changes which the bone has undergone are quite removed. This is a very beautiful example of the influence of that principle which controls the growth of all the parts of the body, which may have its operation deranged by violent injury or by disease ; but which will at last by slow degrees restore the part to its natural form and action. C. B.

CHAP. II.

OF THE SKULL IN GENERAL—THE BONES OF WHICH IT IS COMPOSED—THEIR TABLES—DIPLOE—SUTURES—THEIR ORIGINAL CONDITION, AND THEIR PERFECT FORM, REPRESENTED AND EXPLAINED.

WHILE the bones in general serve as a basis for the soft parts, and supporting and directing the motions of the body, certain bones have a higher use in containing those organs whose offices are the most essential to life. The skull defends the brain ; the ribs and sternum defend the heart and lungs ; the spine contains that prolongation of the brain which gives out nerves to all the body ; and the injuries of each of these are important in proportion to the value of those parts which they contain.

How much the student is interested in obtaining a correct and perfect knowledge of the skull, he must learn by slow degrees. For the anatomy of the skull is not important in itself only ; it provides for a more accurate knowledge of the brain ; explains, in some degree the organs of sense ; instructs us in all those accidents of the head which are so often fatal, and so often require the boldest of all our operations. The marks which we take of the skull, record the entrance of arteries ; the exit of veins and nerves ; the places and uses of those muscles which move the jaws, the throat, the spine. Indeed, in all the human body, there is not found so complicated and difficult a study as this anatomy of the head ; and if this fatiguing study can be at all relieved, it must be by first establishing a very regular and orderly demonstration of the skull.

For this end, we distinguish the face, where the irregular surface is composed of many small bones, from the cranium or skul-cap, where a few broad and flat shaped bones form the covering of the brain. It is these chiefly which enclose and defend the brain, which are exposed to injuries, and are the subject of operation. It is these also that transmit the nerves ; so that the cranium is equally the object of attention with the anatomist and with the surgeon.

All the bones of the cranium, are of a flattened form, consisting of two tables, and an intermediate diploe, which answers to the cancelli of other bones. The tables of the skull are two flat and even plates of bone : the external is thought to be thicker, more spongy, less easily broken ; the inner ta-

ble, again, is dense thin, and brittle, very easily broken, and is sometimes fractured, while the external table remains entire : thence it is named *tabula vitrea*, or the glassy table. These tables are parted from each other by the distance of a few lines ;* and this space is filled up with the diploe, or cancelli. The cancelli, or lattice-work, is a net of membranes, covered with vessels, partly for secreting marrow, and partly for nourishing the bone ; and by the *dura mater* adhering to the internal surface, and sending in arteries which enter into the cancelli by passing through the substance of the bone, and by the *pericranium* covering the external plate, and giving vessels from without, which also enter into the bone, the whole is connected into one system of vessels. The *pericranium*, *dura mater*, and skull, depend so entirely, one upon the other, and are so fairly parts of the same system of vessels, that an injury of the *pericranium* spoils the bone, separates the *dura mater*, and causes effusion upon the brain : a separation of the *dura mater* is, in like manner, followed by separation of the *pericranium*, which had been sound and unhurt ; and every disease of the cancelli, or substance of the bone, is communicated both ways ; inward to the brain, so as to occasion very imminent danger ; outwards towards the integuments, so as to warn us that there is disease. The general thickness of the skull, and the natural order of two tables, and an intermediate diploe, is very regular in all the upper parts of the head. In perforating with the *trepan*, we first cut with more labour, through the external table ; when we arrive at the cancelli, there is less resistance, the instrument moves with ease, there is a change of sound, and blood comes from the tearing of these vessels, which run in the cancelli, betwixt the tables of the skull. Surgeons thought themselves so well assured of these marks, that, it became a rule to cut freely and quickly through the outer table, to expect the change of sound, and the flow of blood, as marks of having reached the cancelli, and then to cut more deliberately and slowly through the inner table of the skull. But this shows an indiscreet hurry, and unpardonable rashness in operation. The patient, during this sawing of the skull, is suffering neither danger nor pain :† and many additional reasons lead us to refuse altogether this rule of practice : for the skull of a child consists properly of one table only : or tables are not yet distinguished, nor the cancelli formed : in youth,

* In Anatomy, there is occasion in almost every description, for a scale of smaller parts. The French divide their inch into twelve parts, each of which is a line. The French line, or twelfth of an inch, is a measure which I shall often have occasion to use.

† There is a state of inflammation, either under the dead bone or in the surrounding bone, which gives extreme pain, even when the silver probe touches the dead bone. C. B.

the skull has its proper arrangement of cancelli and tables ; but still, with such irregularities and exceptions, as make a hurried operation unsafe : in old age, the skull declines towards its original condition, the cancelli are obliterated, the tables approach each other, or are closed and condensed into one ; the skull becomes irregularly thick at some points, and at others thin, or almost transparent ; so that there can hardly be named any period of life in which this operation may be performed quickly and safely at once. But, besides this gradual progress of a bone increasing in thickness and regularity, as life advances, and growing irregular and thinner in the decline of life, we find dangerous irregularities, even in younger skulls.

There are often at uncertain distances, upon the internal surface of the skull, hollows and defects of the internal table, deep pits, or foveæ, as they are called, produced, perhaps, by the impressions of contorted veins. These foveæ increase in size and in number, as we decline in life : they are more frequent on the inner surfaces of the parietal and frontal bones ; so that in those places where the skull should be most regular, we are never sure, and must, even in the safest places, perforate gradually and slowly.

The BONES of the skull are divided into those of the cranium ; the bones of the face ; and common, or intermediate bones.*

* The head is divided into the cranium and face. For the *cranium* we find in old authors the words *calva* or *calvaria* from *calvis*, bald, or sometimes *cerebræ galea* as being like a helmet to protect the brain.

We find some terms distinguishing certain parts of the cranium as *glabella* the smooth part in the centre and lower part of the forehead. *Occiput* the utmost convexity of the head backward. *Vertex*, the crown of the head where the hairs turn. *Bregma*, or *fontanelle*, which are terms derived from very false notions, but which mean the interstices left in a child's skull betwixt the cranial bones.

The student ought to know these terms, but good taste rejects them even from medical language, when the description can be given in plain English.

The following is the usual division of the bones of the head.

In the adult head there are thirty bones and thirty-two teeth.

OF THE CRANIUM, SIX BONES.	INTERMEDIATE OR COMMON BONES, TWO.	BONES OF THE FACE, FOURTEEN.
1 Os Frontis	1 Os Sphenoides	2 Ossa Maxillaria Supra.
2 Ossa Parietalia	1 Os Ethmoides	2 Ossa Malarum
2 Ossa Temporalia		2 Ossa Nasi
1 Os Occipitis		2 Ossa Palati
		2 Ossa Unguis
		2 Ossa Turbinata Infa.
		1 Vomer
		1 Ossa Maxillaria Infa.
BONES OF THE EAR, FOUR ON EACH SIDE.	TEETH, THIRTY-TWO.	
Maleus	8 Incisores	
Incus	4 Cuspidati	
Os Orbiculare	8 Bicuspides	
Stapes	12 Mofaces	

The bones of which the cranium, or skull-cap is formed, are eight in number. 1. The *FRONTAL-BONE*, or bone of the forehead, forms the upper and forepart of the head,—extends a little towards the temples, and forms also the upper part of the socket for the eye. 2. The *PARIETAL BONES*, are the two large and flat bones which form all the sides, and upper part of the head; and are named *parietalia*, as they are the walls or sides of the cranium. 3. The *OS OCCIPITIS*, is named from its forming all the occiput or back of the head, though much of this bone lies in the neck, and is hidden in the basis of the skull. 4. The *OSSA TEMPORUM* form the lower parts of the sides of the cranium: they are called temporal, from the hair that covers them being the first to turn gray, marking the time of life. 5. The *OS ÆTHMOIDES*, and, 6. the *OS SPHENOIDES*, are quite hidden in the basis of the skull: they are very irregular and very difficultly described or explained. The *OS ÆTHMOIDES*, is a small square bone, hollow, and with many cells in it: it hangs over the nose, and constitutes a great and important part of that organ, and at the same time supports the brain. The olfactory nerves, by passing through it at many points, perforate it like a sieve; and it takes its name from this perforated or æthmoid plate. The *OS SPHENOIDES* is larger and more irregular still; placed farther back; locked in betwixt the occipital and æthmoidal bones; lies over the top of the throat, so that its processes form the back of the nostrils, and roof of the mouth; and it is so placed, as to support the very centre of the brain, and transmit almost all its nerves.

SUTURES.—All these bones are joined together by seams, which, from their indented, or dove-tailed appearance, are named sutures.*

* Suture is a common term for the line of contact of the flat bones. It is a form of union admitting of no motion, and is somewhat varied according to the degree of pressure they have to sustain. They may be arranged thus:

JUNCTURA IMMOBILIS.

1. *Sutura Vera*—*Serrata*—*Dentata*.
2. *Sutura Spuria*—*Linea*—*Harmonia*.
3. *Sutura Squamosa*—*Limbosa*,
4. *Gomphosis*.

Monro (*Anatomy of the Human Bones*) expresses the common opinion, that "the suture is formed by the two bones meeting while they are thus flexible and yielding, and have not yet come to their full extent of growth, so that they mutually force into the interstices of each other, till meeting with such resistance as they are not able to overcome, they are stopt from sprouting out further or are reflected, &c." I object to this, because it represents the suture to be an accident. Are not all bones pushed together as here described? yet the true suture is not universal.

It is acknowledged, that there is an object and intention in having the bones of the child's head in separate pieces. The consequence of this is, that sutures are formed when their margins unite. But why is there this variety in the form of the juncture? Certainly this is not accidental. We must notice that when a bone is light and weak it is united by the simple line of contact, or what is called by *Harmonia*. On the contrary, where the bone has to bear pressure, or where it has a

1. The CORONAL SUTURE, is that which joins the frontal to the parietal bones ; extends almost directly across the head, from ear to ear ; descends behind the eye, into the deep part of the temple ; and there losing its serrated appearance, becomes like the squamous or scaly suture, which joins the temporal bones. It is named coronal, because the ancients wore their garlands on this part of the head. But the suture had been better entitled to this name, had it surrounded the head, than as it crosses it.

2. The LAMBDROIDAL SUTURE, is that one which joins the parietals to the occipital bone. It begins behind one ear, ascends and arches over the occiput, and descends behind the other ear. It thus strides over the occiput, in a form somewhat resembling the letter lambda (Λ) of the Greeks, whence its name.

3. The SAGITTAL SUTURE, joins the parietal bones to each other ; runs on the very top of the head ; extends forwards from the lambdoid suture till it touches, or sometimes passes, the coronal suture ; and from lying betwixt these two sutures, like an arrow betwixt the string and the bow, it has been named sagittal.

4. The TEMPORAL SUTURES, join the temporal bones to the parietal, occipital, and frontal bones ; the sphenoid bone also enters into the temporal suture, just behind the eye. The temporal suture makes an arch corresponding almost with the arch of the external ear ; it meets the coronal suture an inch before the ear, and the lambdoidal an inch behind it. This back part belongs as much to the occipital as the temporal bone ; and so has been named sometimes, *additamentum suturæ lambdoidalis* ; sometimes *additamentum suturæ squamosæ* : for this temporal suture is, on account of the edge of the temporal and occipital bones being thin, and like scales of armour laid over each other, often named the squamous or scaly suture.

5. The SPHENOIDAL and ÆTHMOIDAL SUTURES, are those which surround the many irregular processes of these two bones, and join them to each other and to the rest.

more important organ to protect, it is thick and firm, and it is joined by the indented suture, which is a union by a more perfect mechanism, and gives strength proportioned to the bone. Thus we see that the bones of the cranium are united by the true suture. But the most perfect specimen of the true suture will be found in the skulls of horned cattle, because this instrument of defence must be reared on a firm foundation.

Further, the anatomist repeats from day to day and year to year, that the squamous suture is made by the pressure of the temporal muscle ; an accident again. No : it is formed for a purpose, it is the kind of suture the best calculated to bind in the cranial bones, and to prevent the starting of the parietal bones. He does not contemplate the structure of the body in a proper temper of mind, who looks upon these admirable provisions as the effect of accident. C. B.

6. The TRANSVERSE SUTURE, is one which, running across the face, and sinking down into the orbits, joins the bones of the skull to the bones of the face ; but with so many irregularities and interruptions, that the student will hardly recognize this as a suture.

7. The ZYGOMATIC SUTURE, is one which joins a branch of the temporal bone, to a process of the cheek bone ; forming an arch, zygoma, or yoke ; but this suture has no extent, it is a serrated appearance at one single point only.

To mark and know these sutures, and to be able to trace them in imagination, upon the naked head, to foresee where a suture will present, and how far it runs, may be a matter of great importance to the surgeon. Hippocrates, who has had more to praise his honesty than to follow his example, acknowledges his having mistaken a suture for a fracture of the skull ; and since this warning, various contrivances and marks have been thought of, for preventing the like mistake. It may be useful to remember that the suture has its serræ or indentations, is firmly covered by the pericranium, is close, and does not bleed : but that a fissure, or fracture of the skull, runs in one direct line, is larger and broader at the place of the injury, and grows smaller as you recede from that, till it vanishes by its smallness ; and that it always bleeds. Indeed, the older surgeons, observing this, poured ink upon the suspected part, which, if the skull was hurt, sunk into the fissure, and made it black and visible ; but left the suture untouched. They also directed to make the patient take a wire betwixt his teeth, which being struck like the string of an instrument, he would feel the twang produce a painful and particular sensation in the fractured part of the head. But after all these observations, in place of any true and certain marks, we find a number of accidents which may lead us into a mistake.

Sutures cannot be distinguished by their serræ or teeth, for the temporal sutures want this common character, and rather resemble capillary fractures of the skull ;* nor even by their places, for we know that there are often insulated bones (*ossa Wormaniana*) surrounded with peculiar joinings, which so derange the course of the common sutures, that the joinings may be mistaken for fractures of the skull, and the *ossa Wormaniana* for broken parts. Sometimes the squamous suture is double, with a large arch of bone intercepted betwixt the true and the false suture ; or the sagittal suture, descending beyond its usual extent, and quite to the nose, has been mistaken for a fracture, and trepanned ; and oftener in older skulls, the su-

* Viz. Fractures as small as a hair, thence named capillary.

tures are entirely obliterated, all over the head. If the surgeon should pour ink upon the skull, he would have reason to be ashamed of an experiment so awkward and unsuccessful; and for the old contrivance of a wire or cord held in the mouth, it cannot be done, since the patient is commonly insensible: and even, though less hurt, his feelings, after such an accident, must be very confused; he must be too liable to be deceived: and we cannot on such slender evidence as this, perform so cruel an operation as cutting up the scalp, or so dangerous a one as the trepan.

For various reasons we are careful to trace the bones from their original soft and grisly state, to their perfect condition of hard bone: and most of all, we are concerned to do so in the head, where, in childhood the appearances are not singular and curious only, but have always been supposed to indicate some wise and useful purpose. It is in this original condition of the soft and growing bones, that anatomists have sought to find a theory of the sutures, how they are formed, and for what uses. It has been remarked, that the number of pieces in the skull, is infinitely greater in the child than in the man. These bones ossifying from their centre towards their circumference, it happens, of course, that the fibres are close at the centre of ossification, and are more scattered at the extremities of the bone: when these scattered fibres of opposite bones meet, the growing fibres of one bone shoot into the interstices of that which is opposed: the fibres still push onwards, till they are stopped at last, and the perfect suture, or serrated line of union is formed.

In dilating this proposition, we should observe, that in the boy, all the bones in the head are membranous and imperfect. The membranous interstices begin to be obliterated; the sutures are beginning to close; the distinction of two tables is not yet established; the cancelli are not yet interposed between the plates, the sinuses, or caverns of the bones, as in the forehead, the nose, and the jaw, are not formed; and each bone is not only incomplete towards its edges and sutures, but consists often of many parts. The *OS FRONTIS* is formed of two pieces, which meet by a membranous union in the middle of the bone. The *OSSA PARIETALIA* have one great and prominent point of ossification in the very centre of each, from which diverging rays of ossification extend towards the edges of the bone. The *OS OCCIPITIS* is formed in four distinct pieces: and the *TEMPORAL BONES* are so fairly divided into two, that their parts retain in the adult the distinct names of petrous and squamous bones. Although these are all the regular points of ossification, yet sometimes there occur small

and distinct points, which form irregular bones, uncertain in number or size, found chiefly in the lambdoid suture, sometimes numerous and small, more commonly they are few in number, and sometimes of the full size of a crown, always distorting more or less the course of the suture, and being thus a subject of caution to the surgeon: these are named *ossa TRIQUETRA*, or *TRIANGULARIA* from their angular shape, or, *WORMIANA*, from Olaus Wormius, who remarked them first. Now the *os frontis* being formed into two larger pieces, their edges meet early in life, and they form a suture; but the bones continuing to grow, their opposite points force deeper and deeper into each other, till at last the suture is entirely obliterated, and the bones unite, and so this suture is found always in the child, seldom in the adult, almost never in old age. The occipital bone having four points, they are closer upon each other, they meet early, are soon united; and, although very distinct in the child, no middle suture has ever been found in the adult, but always the four pieces are united into one firm and perfect bone. The parietal bones have their rays most of all scattered; the rays of ossification run out to a great distance, and diverge from one single point, so that at their edges they are extremely loose, and they never fail to form sutures, by admitting into their interstices the points and edges of the adjoining bones. The surest and most constant sutures are those formed by the edges of the parietal bones; the sagittal in the middle, the coronal over the forehead, the lambdoidal behind, and the squamous suture, formed by their lower edges. But another phenomenon results at the same time, from this meeting and opposition of the fibres and interstices of the growing bones: that when the opposite fibres meet too early, they are not fairly admitted into the open spaces of the opposite bone; but the fibres of each bone being directly opposed point to point, they both turn inwards, and form a ridge or spine, such as is seen on the inner surfaces of the frontal and occipital bones. Such is the common theory, which I suspect is imperfect, and which should be received with some reserve, for all the phenomena are not yet explained; we find each suture always in its appointed place; we find nothing like a suture formed betwixt the head and body of a long bone, though they are formed in distinct points, and are united till after the years of manhood; we find no sutures when bones are broken and reunited, when they have been spoiled and are replaced, when a piece of spoiled bone has been cut away, nor when a new shaft of a bone is formed by the secreting vessels, and is united to the heads of the old bone. These are accidents which hold us at least in doubt.

It has been supposed, and with much appearance of truth, that the sutures limit the extent of fractures, leave a free communication of the internal with the external parts; that they must serve as drains from the brain; that they are even capable of opening at times, so as to give relief and ease in the most dreadful diseases of the head. But I fear we are not yet able to see the meaning of this peculiarity of structure; for the sutures are regular and uniform to a wonderful degree, while these uses of them are far from being proved.

The sutures surely were not intended by nature for limiting the extent of fractures; for fractures traverse the skull in all directions; cross the sutures with ease; and very often, passing all the sutures, they descend quite to the basis of the skull, were we dare not follow them with the knife, nor apply the trepan. Indeed we do not even know that limiting the extent of fractures could be a gracious provision of nature, since it would rather appear by the common accidents, that the more easily the bone yields, the less is the injury to the brain; and that where the fracture is wide and large, the symptoms are milder, and the danger less.

Neither were they intended as drains; for surely it is a bold position to assume, that nature has carefully provided for our making issues upon the sutures. When the original openness of the head and the membranous condition of the sutures was first observed, it was thought to be an observation of no small importance. The ancients believed that the membranes of the brain came out by the sutures, to form the pericranium, and going from that over the several joints, formed the periosteum for all the bones. They saw a close connexion betwixt the external and internal membranes of the skull, and they thought that nature had intended there a freer communication, and occasional drain. They found the sutures particularly wide and membranous in a child, which they attributed to the watery state of its brain, requiring a freer outlet than in the adult: and accordingly they named the opening of the child's head the bregma, fons, fontanella, the fountain, by which they believed there was a continual exudation of moisture from the brain.

We might have expected these notions to have vanished with the doctrines of humours and revulsion which gave rise to them; but both the doctrines and the practice, have been revived of late years; and a surgeon of some eminence has been at pains to examine various skulls, trying to find which of all the sutures remains longest open, and which should form the readiest and surest drain; and after a curious examination of each, he decidedly condemns the fontanelle; finds the ad-

ditamentum of the squamous suture always open, and expects this superior advantage from placing his issues there, that he will command at once a drain both from the cerebellum and from the brain. But these notions of derivation and revulsion, of serous humours falling upon the brain, of drains of pituita by the nose, and through the sutures, were much cherished by the ancients, had been long forgotten, and have not been effectually revived by this attempt.

It cannot be denied, that, in some instances, the sutures have continued quite open in those grown in years, or have opened after a most wonderful manner, in some diseases of the head.

A young man having been brought into an hospital ill of a fever, the physicians observed with surprise, a very strong pulsation behind the ear: upon applying the finger, a strong beating was felt; the part was soft and yielding; and upon opening his head, after death, there was found a large membranous space. Diemorbrock found the fontanelle open in a woman of forty years of age. Baubin says, that in his own wife, twenty-six years of age, the sutures were not yet closed.

This fontanelle, or opening at the meeting of the coronal and sagittal sutures, was once thought to be a sure mark for the accoucheur to judge by, both of the life of the child, and of the direction in which its head presents. It is large and soft in a child, and the good women lay a piece of firm cloth upon it, and defend it with particular care. It begins to contract from the time of birth; and in the second and third year, it is entirely closed. Its closing is delayed by weakness, scrophulous complaints, and indeed by any lingering disease; it closes very late in rickets, and in hydrocephalic children the bones never close, but continue soft, yield to the watery swelling of the brain, and separate in a wonderful degree, so as to hold ten or twelve pounds.

As the sutures continue open in a hydrocephalic child, they are said to open again in the few instances where adults are seized with the same disease. We are told that it opens in those dreadful head-aches which are sometimes fatal, and that the celebrated Paschal having died after terrible torments, was found to have the sutures opened again: it is even said that they open during disease, and close after the cure. "That
" a man of forty years of age, being in the dog days, seized
" with a raging fever, delirium, watching, and dreadful pains
" of the head, his sutures opened on the seventh day, were
" as wide as in a child, not only so as to be distinguished by
" the finger, but that the attendants could see the pulsations
" of the brain: the fever, after some time, abated; the

"pains ceased; the sutures closed, and this man lived many years in perfect health." So Hildanus reports the case, and he also says, in another instance, that the sutures had parted in a violent hemicrania, with an audible noise.

Yet if this were a regular design of nature, the relief should be perfect; perhaps the opening of the sutures should be more easy, and the accident almost as common as diseases of the head; or perhaps it had been the more merciful order, to have determined a quick and sudden period for such dreadful and incurable diseases as these.

The sutures of the cranium are accidental merely, and of little use. The result, perhaps, of this well known law, that nature seeks to facilitate ossification, by beginning the process in many points; and she establishes as many distinct points in healing a broken limb as in forming the skull. But however they may be formed, their uses cannot be of that importance which has been supposed; for there are twenty separate bones, and twenty sutures in the face, where they can neither stop fractures, nor serve as drains, nor open so as to give relief.

But if the sutures of the cranium have any thing peculiar and different from those of the face, in that, perhaps, their peculiar uses may be found. We cannot pass unnoticed their looseness and flexibility in the new-born child; how wonderfully the head of the child is increased in length, and reduced in breadth in the time of delivery, and how much this conduces to an easy and happy labour.

The most eminent anatomists have condescended to remark, that in the various nations of Europe, the head has various forms, which they ascribe to so slight a pressure as that which dress, or even the posture of the head might produce. But how very far Vesalius was deceived in calculating thus, is easily proved. The Turks, says he, have their heads flattened by wearing the turban. But the turban is an eastern dress: the Turks or Tartars are a northern people, who assume this dress only when conquest brings them into a warmer climate, and the prominent cheek-bones, parted eyes, and flat heads, continue in the Tartars, who have but newly assumed the turban, while the conquered nations which have worn it long, are distinguished by their regular and beautiful features. Perhaps by contrivance and force, we may distort the head of a child; and we may almost believe what is told of the negroes of the Caribbee islands, who had contrived, by pressure, to flatten their children's heads, that their race might be in future distinguished from those who had submitted to the Spanish yoke; or of what is told so often of eastern nations, that they sometimes mould the heads of children into monstrous and uncouth

forms, to extort charity, or as an act of religion. Were I to assign a reason for the flexible bones, and wide sutures, and the yielding condition of the head of the child, I should say that it were meant by nature to stand in the place of that separation of the bones of the pelvis which has been supposed, but which cannot exist; for the child's head is moulded with little injury, is evolved again without help; and it seems a provision of nature, since the child scarcely feels the change: but no woman has been known to have the joinings of the pelvis relaxed or dissolved without pain and danger, confinement for many months, a temporary lameness, and sometimes she is rendered unable for life.

CHAP. III.

DESCRIPTION OF THE INDIVIDUAL BONES OF THE SKULL.

OS FRONTIS. This bone is compared with a clam-shell. It is of a semicircular shape, hollowed like a shell. It is marked on the inside by a spine, or prominent line, which divides the hollow of the bone into two equal parts, and gives rise to a membranous partition, which divides and supports the hemispheres of the brain. It is marked on its external surface by those high ridges on which the eye-brows are placed, and by two prominences, which are hollow caverns, named the *SINUS* (or *cavities*) of the frontal bone. Its orbital plates are the two thin and delicate lamellæ that depart from the general direction of the bone, and stand out horizontally, so as to form a part of the socket for the eye, or, as it were, a roof defending the upper part of the eye, and a floor for supporting the lower part of the brain; and these two orbital plates leave an open space, in which is incased the chief part of the *æthmoid* bone, viz. *incissura æthmoidea*.

The frontal bone stands connected with the parietal bones by the coronal suture; it is connected to the great ala of the sphenoid bone by the *sutura speno frontalis*; while its orbital plates are united to the lesser ala by the *linea speno frontalis*. The nasal bones are attached to it by part of the transverse suture of the face. The cribriform plate of the *æthmoid* bone is united to the orbital plates by the *linea æthmoidea frontalis*, and looking into the orbits the same or-

bitary plates are seen to be contiguous to the ossa plana and ossa unguis; and, lastly, the ossa malarum are attached to the frontal bone by the extremities of the transverse suture of the face.

The first point to be remarked, is the SUPERCILIARY RIDGE, on which the eye-brows are placed: it is a prominent arched line, corresponding in size and length with the eye-brow which it supports: over this line the integuments are loose: here many arteries perforate the bone, which are properly the nutritious arteries of this part of the bone; and we find all over the superciliary ridge many small holes through which these arteries had passed. Among these, there is one hole which is larger, and which is distinguished from the rest; for its use is not like the others, to transmit arteries to the bone, but to give passage to the frontal nerve and a small artery which comes out from the orbit, to mount over the forehead. Sometimes the nerve turns freely over the border of the orbit, and makes no mark, or but a slight one: often lying closer upon the bone, it forms a notch; but most commonly, in place of turning fairly over the edge of the orbit, it passes obliquely through the superciliary ridge, and by perforating the bone, makes a hole: this hole is named the SUPERCILIARY HOLE. The artery which comes from the eye to go out upon the forehead is named, where it passes, the superciliary artery; and higher up upon the forehead, the frontal artery: it establishes a communication betwixt the internal arteries of the eye, and external arteries of the forehead and temple. We are always warned of the danger of wounding arteries where they pass through bones; and strange stories are told of the terrible bleedings which have arisen from this artery, wounded near its hole, and of the convulsions, palsies, and loss of sight, which have arisen from the accidents, wounds or lacerations of this frontal nerve; stories delivered on such authorities as we dare not refuse, and yet cannot easily believe.

The second foramen is the FORAMEN ORBITALE INTERNUM, which transmits a branch of the ophthalmic division of the fifth nerve into the cranium, and finally into the nose. There is frequently another foramen in the orbital plate, which transmits a small vessel from the orbit to the nose.

The orbital, or superciliary ridge, ends by two processes, which, forming the angles of the eye, are named the ANGULAR PROCESES. The frontal bone has, therefore, four angular processes: 1. The two internal angular processes, forming the internal angles of the eyes; and 2. The two external angular processes which form the external angles of each eye.

Betwixt the two internal angular processes there is the NA-

NASAL POINT OR PROCESS. This nasal process is a small sharp projecting point, occupying that space which is exactly in the middle of the bone, and is betwixt the two internal angular processes. It is very irregular and rough all round its root, for supporting the two small nasal bones; and this gives them a firm seat, and such a hold upon the root of the forehead, that they oftener are broken than displaced.

From the external angular process there extends backwards and upwards the temporal ridge or spine.

At the inner end of the superciliary ridge, is that bump which marks the place of the frontal sinus, which also indicates their size; for where this rising is not found, the sinuses are wanting, or are very small; but this is no sure nor absolute mark of the presence of these sinuses, which often, in the flattest foreheads, are not easily wanting.

The sinuses* of the *os frontis* are two in number, one on either side above the root of the nose: they are formed by a receding of the two tables of the skull from each other: they are formed at first with the common cancelli, and at first they resemble the common cancelli, as if they were only larger cells: gradually they enlarge into two distinct cavities, often of very considerable size, going backwards into the orbitary plate, or sideways into the orbitary ridge, or upwards through one half of the frontal bone; and Ruysch had, in a giantess (*puella gigantica*,) seen them pass the coronal suture, and extend some way into the parietal bones.

The two sinuses of either side are divided by a partition; but still they communicate by a small hole: sometimes the partition is almost wanting, and there are only crossings of the common lamellated substance; and though the communication with one another is not always found, they never fail to communicate with the nose: this indeed seems to be their chief use; for the frontal sinuses are the beginning of a great train of cells, which, commencing thus in the frontal bone, extend through the æthmoidal, sphenoidal, and maxillary bones, so as to form an organ of great extent and use belonging to the nose; but perhaps not so much for extending the organ of smelling, as for making a more sonorous voice; for we have no proof that the sinuses are part of the organ of smell; unless we should accept of this as a proof, that, by smelling of strong volatiles, pain shoots upwards into the forehead; though

* The word sinus is used in two senses: we call the cavities or cells, within the substance of a bone, the sinuses of that bone: as the sinuses of the forehead, of the sphenoid, æthmoid or maxillary bones: we call also certain great veins by the same name of sinuses; thus the great veins being enlarged where they approach the heart, and the veins being particularly large in the brain and the womb, we call them the sinuses of the heart, of the brain, and of the womb.

by the same rule, the eyes should be also a part of the same organ, since they are pained, and tears begin to flow : but we do know that they belong to the voice, and raise its tone, for we feel the trembling note resound through all these cells, so that the voice is sonorous while they are free ; is damped when the sinuses are oppressed by their membranes being thickened by cold ; or is almost suppressed when the sinuses are entirely closed ; or when, by venereal ulcers, the curtain of the palate is consumed, no part of the voice passing upwards into the nose, it is almost lost.

This has given rise to a very common mistake : that as these sinuses are wanting in the child whose forehead is flat, as they enlarge gradually, and are fully formed about the fifteenth year, the *vox rauca*, the breaking of the voice, which is observed about that time, must be owing to the evolution of these cells : but the female voice does not undergo the same change by the evolution of these cells ; and castration, which surely can have no effect on these cavities, keeps down the eunuch's to the treble key of the female voice.* The mistake lies in supposing these cavities to raise the tone or note in which we speak, while they only add clearness and strength. The membrane which lines these cavities is thin, exquisitely sensible, and is a continuation of the common membrane of the throat and nose. A thin humour is poured out upon its surface to moisten it and keep it right. This the ancients did not consider as a mere lubricating fluid, but as a purgation of the brain, drawn from the pituitary gland, which could not be diminished without danger, and which it was often of consequence to promote.

They are subject to one accident chiefly, viz. insects which nestle there, and produce inconceivable distress ; and it is particular, that they more frequently lodge in the frontal sinuses, than in the cavities of any of the other bones. In sheep and dogs such insects are very frequent, as in seeking their food, they carry their nose upon the ground ; and it has been proved, or almost proved, that in man they arise from a like cause. Indeed, what can we suppose, but that they get there by chance ; thus, a man having slept in barns, was afflicted with dreadful disorders in the forehead, which were relieved upon discharging from the nose, a worm of that kind which is peculiar to spoiling corn ; while others have had the complaint, by sleeping upon the grass. But there is something very particular in this, that far the greater number of these worms have

* I have seen a boy of four years of age, whose parts of generation were prematurely developed with bushy hair upon the pubes. This man-child had the rough broken voice, though the bones of the forehead were flat. C. B.

been of the centipede kind ; generally long, an inch in length, with one hundred, or, according to Linnaeus, one hundred and twelve feet, and not unfrequently covered with hair. There are reports which seem to prove, that some have died of this complaint, and in a very miserable way. In many cases it has been attended with delirium ; and in almost every instance it has continued for years. No wonder, then, that the trepanning of these sinuses has often been proposed ; but I have never read of a well marked case, so that we could be assured beforehand of finding worms : they have, in most cases, been discovered rather by chance. The patient might be relieved on easier terms, by the injection of aloes, assafœtida, myrrh, the use of snuff or smoking, and pressing the fumes upwards into the nose. Much should be tried, before undertaking a dangerous operation on such slender proofs.

It may be right in cases of fractures, to decline applying the trepan above the sinuses, unless a fracture cannot be raised in any easier way ; and we must be especially careful to distinguish a fracture of the outer table only, from entire fractures of this bone. For Palfin says, that the outer table being broken, and the natural mucus of the sinus being corrupted and flowing out, has been mistaken for the substance of the brain itself. And Parèe, who first gives this caution, affirms, “ that he had seen surgeons guilty of this mistake, applying the “ trepan, and so killing their unhappy patients.”*

The SPINE OR RIDGE which runs upon the internal surface of the frontal bone, is to be observed, as it gives a firm hold to the falx, or that perpendicular membrane, which running in the middle of the head, divides and supports the brain. This is more or less prominent in different skulls, and according to the age. The spine is more prominent at its root ; but as it advances up the forehead, it decreases, and often ends in a groove. The spine gives firm hold for the falx, and the groove lodges the great longitudinal sinus, or in other words, the great vein of the brain, which runs along the head, in the course of the perpendicular partition, or falx. At the root of this spine, there is a small blind hole ; it is named blind, because it does not pass quite through the bone, and the beginning of the falx, dipping down into this hole, gets a firmer hold. The ancients, thinking that the hole descended through both tables into the nose, believed that the dangerous and ungovernable bleedings at the nose must be through this hole, and from the fore end, or beginning of the longitudinal sinus.

* For a more perfect account of the pathology of the sinuses, see the Surgery, 4to. vol. ii.

The ORBITARY PROCESS already described is the most remarkable point of the frontal bone. The orbitary processes are two thin plates, departing from the general direction of the bone, and standing inwards at right angles: they cover the eye, and support the brain. By the continual rolling of the eye, and the pressure of the brain, they are extremely thin and transparent; the rolling of the eye makes them exquisitely smooth below, and on their upper surfaces, they are impressed with the frequent convolutions of the brain; so that a wound through the eye endangers more than the eye; for it passes easily forward into the brain, and is instantly fatal; it is the aim of the fencer, and we have known in this country a young man killed by the push of a foil, which had lost its guard.

Upon the orbitary plate, and just under the superciliary ridge, there are two depressions in the socket of each eye; the one is very small, and deeper at the inner corner of the eye, under the superciliary hole, which is the mark of the small cartilaginous pulley, in which the tendon of one of the muscles of the eye plays; the other, a more gentle and diffused hollow, lies under the external angular process, is not deep, but is wide enough to receive the point of a finger, and is the place where the lachrymal gland lies, that gland which secretes the tears, and keeps the eye moist.*

PARIETAL BONE.—The parietal bones form much the greater share of the cranium: they are more exposed than any others, are the most frequently broken, and the most easily trepanned; for the parietal bones are more uniform in their thickness, and more regular in their two tables and diploe, than any others. But the accidental varieties of pits and depression are very frequent in them, and the sinus or great vein, and the artery which belongs to the membranes of the brain, both make their chief impressions upon this bone.

The square form of the bone produces four angles; and in surgery, we speak of the frontal, the occipital, the mastoidean, and temporal angles, of the parietal bone.† It has deeply serrated edges, which unite the two bones with each other, and with the occipital and frontal bones. All the corners of this bone are obtuse, except that one which lies in the temple, and which, running out to a greater length than the other corners, is sometimes named the SPINOUS OR TEMPORAL PROCESS of the parietal bone, though there can be no true process in a bone so

* In addition, as points of demonstration, we may add the *eminentiæ frontales*, and *superciliares*.

† It enters into the *coronal*, the *sagittal*, the *lambdoidal*, and the *squamosal* sutures.

regular and flat. The lower edge of the bone is a neat semi-circle, which joins the parietal to the temporal bone; and the edge of each is so slanted off, that the edge of the temporal overlaps the edge of the parietal, with a thin scale, forming the squamous suture. About an inch above the squamous suture, there is a semi-circular ridge, where the bone is particularly white and hard; and rays extend downwards from this, converging towards the jugum. The white semi-circular line represents the origin of the temporal muscle; and the converging lines express the manner in which the fibres of the muscle are gathered into a smaller compass, to pass under the jugum, or arch of the temple. The sagittal suture, or meeting of the two parietals, is marked with a groove as big as the finger, which holds the longitudinal sinus, or great vein of the brain; but the groove is not so distinctly seen, unless the two bones are put together; for one half of this flat groove belongs to each bone.

The great artery of the dura mater touches the bone at that angle of it which lies in the temple. It traverses the bone from corner to corner, spreading from the first point, like the branches of a tree: it beats deep into the bone where it first touches it; but where it expands into branches, its impressions are very slight; commonly it makes a groove only, but sometimes it is entirely buried in the bone; so that at the lower corner of the parietal, we cannot escape cutting this vessel, if we are forced to operate with the trepan.

There is but one hole in the parietal bone: it is small and round, is within one inch of the meeting of the lambdoidal and sagittal sutures, and gives passage to a small external vein, which goes inwards to the sinus, and to a small artery which goes also inwards to the dura mater, or rather to the falx.

On the inner surface of the bone, and near the sagittal edge, we very often see a pit or foveæ, which receives one of those bodies which are called glands, of the dura mater.

The lateral sinus makes a depression on the inside of the mastoidean angle.

The meeting of the frontal and parietal bones, being imperfect in the child, leaves that membranous interstice which, by some, is named folium or folliolum, from its resembling a trefoil leaf, and was named by the ancients hypothetically, *bregma, fons*,* or fountain; they thinking it a drain of moisture from the brain; and so the parietal bones are named *ossa bregmatis*.

* The word *pulsatilis*, or *fons pulsatilis*, or beating fountain, was added, because we feel the beating of the arteries of the brain there.

OS OCCIPITIS, has also the names of *os memoriæ*, and *os nervosum*.* It is the thickest of the cranial bones, but it is the least regular in its thickness, being transparent in some places, and in others swelling into ridges of very firm bone. It gives origin or insertion to many of the great muscles, which move the head and neck; it supports the back part of the brain, contains the cerebellum or lesser brain, transmits the spinal marrow, and is marked with the conflux of the chief sinuses, or great veins of the brain.

This bone is united to the parietal bones by the lambdoid suture, to the mastoidean portions of the temporal bone by the *additamentum suturæ lambdoidalis*, laterally and forward it is attached to the petrous portion of the temporal bone, and at its lower and most anterior part, it is attached to the sphenoid bone, by that peculiar bond of union called *synostosis*.

The **EXTERNAL SURFACE** is exceedingly irregular, by the impressions of the great muscles of the neck: betwixt the insertions of the muscles, projecting lines are on the bone. In the middle of the bone, and betwixt the muscles of opposite sides, there runs a ridge from above downward; at the upper margin of the insertion of the trapezius, there is formed a superior transverse spine or ridge, and in the same way, directly above the insertion of the recti, which make two irregular depressions, there is an inferior transverse spine. In a strong man, advanced in years, where the ridges and hollows are strongly marked, the point where the superior transverse crosses the perpendicular one, it is so very prominent, as to be named the **POSTERIOR TUBEROSITY** of the occipital bone.

The **INTERNAL SURFACE**. Opposite to these ridges there are similar crucial ridges within; but larger, more regular, smooth, and equal, and making only one transverse line, and one perpendicular line. The *tentorium cerebello super-extendum*, is a diaphragm or transverse partition, which crosses the skull at its back part; cuts off from the rest of the cranium the hollow of the occipital bone, appropriates that cavity for the cerebellum, and defends the cerebellum from the weight and pressure of the brain. This tentorium or transverse membrane, is attached to the **GREAT INTERNAL RIDGE** of the occipital bone. In the angle where this membrane is fixed to the ridge, lies the great sinus or vein, which is called **longitudinal sinus**, while it is running along the head; but the same

* In beginning the demonstration, we point out its divisions: 1. *Pars occipitalis*. 2. *Pars lateralis* or *condyloidea*. 3. *Pars basilaris* or *cuniformis*; which at birth are distinct bones divided by cartilage. It is also necessary to name its angles, viz. the superior or parietal angle, and the mastoidean angle.

sinus, dividing in the back of the head, into two great branches changes its name with its direction; and the forkings of the vessel are named the right and left lateral sinuses, which go down through the basis of the skull; and being continued down the neck, are there named the great or internal jugular veins. This forking of the longitudinal, into the lateral sinuses, makes a TRIANGULAR or TRIPOD-LIKE GROOVE, which follows the internal ridges of the occipital bone: and above and below the transverse ridge there are formed four plain and smooth hollows. The two upper ones, are above the tentorium, and contain the posterior lobes of the brain; the two lower ones are under the tentorium, and hold the lobes of the cerebellum or little brain.

PROCESSES. The processes or projections of the occipital bone are few and simple. 1. There is a part of the bone which runs forward from the place of the foramen magnum, lies in the very centre of the base of the skull, joins the occipital to the sphenoidal bone, and which, both on account of its place, (wedged in the basis of the skull,) and of its shape, which is rather small, and somewhat of the form of a wedge, is named the CUNIFORM, or WEDGE-LIKE PROCESS of the occipital bone. On the inside of this part of the bone is a slight hollow, to which the name of fossa basilaris is given, and lateral to this the groove of the lower petrous sinus may be observed. And there are two small oval processes, or button-like projections, which stand off from the side, or rather from the forepart of the foramen magnum, or great hole, and which, being lodged in joints belonging to the upper bone of the neck, form the hinge on which the head moves. These two processes are named the CONDYLES of the occipital bone. They are not very prominent, but rather flattened; are of an oval form, and have their fore-ends turned a little towards each other; so that by this joint the head moves directly backwards or forwards, but cannot turn or roll. The turning motions are performed chiefly by the first bones of the neck. Round the root of each condyle, there is a roughness, which shows where the ligament ties this small joint to the corresponding bone of the neck.

On the lower part of the cuniform process, there are two tubercles for the attachment of the recticapitis anteriores. Near the condyle, and immediately behind the foramen lacerum there is a tubercle for the rectus capitis lateralis.

HOLE.—These condyles stand just on the edge of the FORAMEN MAGNUM, or great hole of the head, which transmits the spinal marrow, or continuation of the brain; and the edges of this hole (which is almost a regular circle) are turned and

smoothed ; a little thicker at the lip, and having a roughness behind that giving a firm hold to a ligament, which, departing from this hole, goes down through the whole cavity of the spine, forming at once a sheath for the spinal marrow, and a ligament for each individual bone. There passes down through this great hole the spinal marrow, and the vertebral vein. There comes up through it the vertebral arteries, which are of great importance and size ; and a small nerve, which, from its coming backwards from the spine to assist certain nerves of the brain, is named the spinal accessory nerve.

The second hole is placed a little behind the ring of the foramen magnum, and, just at the root of either condyle, is round and large, easily found, and sometimes it is double ; it transmits the ninth pair, or great lingual nerve.

There is another hole smaller, and less regular than this last. It is exactly behind the condyle, while the lingual hole is before it. It is for permitting a small vein of the neck to enter and drop its blood into the great lateral sinus ; but often it is not formed, and this trifling vein gets in by the great occipital hole.

We shall describe with the temporal bone that wide hole which is common to the temporal and occipital bones, and which transmits the great lateral sinus.

TEMPORAL BONE.—The temporal bone is, in the child, two bones ; which retain their original names of *pars petrosa* and *pars squamosa*. The whole bone is very irregular in its thickness, and hollows, and processes. The *PARS SQUAMOSA* is a thin or scaly part, rises like a shell over the lower part of the parietal bone, and is smoothed and flattened by the rubbing of the temporal muscle. The *PARS PETROSA*, often named *OS LAPIDOSUM*, or stony bone, is hard, irregular, rocky ; just inwards towards the basis of the skull ; contains the organs of hearing, and, of course, receives and transmits all the nerves which are connected with the ear.* There is a third portion of this bone, viz. the mastoidean angle, which is thick and hard, is divided into cells, and forms those caverns which are supposed to be chiefly useful in reverberating the sound.

The squamous part is grooved, to make the squamous suture ; is scolloped or fringed ; and exceedingly thin on its edge ; it is radiated, in consequence of its original ossification shooting out its rays. The petrous part again is triangular, unequal by the cavities of the ear ; it has a very hard, shining, polished-like surface ; exceeded in hardness by nothing but

* The interior and posterior semi-circular canals are protuberant upon its surfaces.

the enamel of the teeth. Where it projects into the base, it has several open points, which are filled up with cartilaginous or ligamentous substance; and its occipital angle is connected with the other bones by the *additamentum suturæ squamosæ*.

The temporal bone closes the cranium, upon the lower and lateral part; backwards it is connected by the *additamentum suturæ lambdoidalis* to the occipital bone; by the squamous suture and the *additamentum suturæ squamosæ*, it is joined to the parietal bone; whilst anteriorly it is united to the sphenoid bone by the sphenotemporal suture, the spinous process of the sphenoid bone being deeply wedged betwixt the petrous and squamous portions of the temporal bone.

PROCESSES. The ZYGOMATIC PROCESS rises broad and flat before the ear; grows gradually smaller as it stretches forward to reach the cheek-bone; it forms with it a zygoma, yoke, or arch of the temple, under which the temporal muscle plays. The temporal muscle is strengthened by a firm covering of tendon, which stretches from the upper edge of this zygoma to the white line on the parietal bone; and several muscles of the face arise from the lower edge of the zygoma, particularly one named *masseter*, which moves the jaw; and one named *zygomaticus*, or *distorter oris*, because it draws the angle of the mouth. The zygomatic process is united by a short suture to the cheek bone.

The STYLOID PROCESS is so named from a slight resemblance to the stylus, or point with which the ancients engraved their writings on tables of wax. It is cartilaginous long after birth; even in the adult, it is not completely formed; it is exceedingly delicate and small; and when its cartilaginous point is fairly ossified, as in old men, it is sometimes two inches long. It stands obliquely out from the basis of the head, and is behind the jaws; so that it gives convenient origin to a ligament which goes downwards to support the *os hyoides*, or bone of the tongue; and it is the origin of many curious muscles, chiefly of the throat and jaws. One slender muscle going downwards from the styloid process, and expanding over the pharynx, is called *stylopharyngeus*; one going to the *os hyoides*, is the *stylohyoideus*; one going to the tongue, is the *styloglossus*: and since the process is above and behind these parts, the muscles must all pull backwards and upwards, raising according to their insertions, one the pharynx, another the *os hyoides*, another the tongue.

PROCESSUS VAGINALIS will not be easily found, nor acknowledged as a process; for it is only a small rising of a ridge of the bone, with a rough and broken-like edge, on the middle of which the styloid process stands: it is, in short, the

root of the styloid process which anatomists have chosen to observe, though it gives origin to no particular part; and which they have named vaginalis, as if it resembled a sheath for the styloid process.

MASTOIDEUS or **MAMMILLARIS**, is a conical nipple-like bump, like the point of the thumb; it projects from under the ear, and is easily felt with the finger without; it is hollow, with many cells which enlarge the tympanum, or middle cavity of the ear, and are thought to reverberate and strengthen the sound. Under its root, there is a deep and rough rut which gives a firm hold to the first belly of the digastric muscle; and the point or nipple of this process is the point into which the mastoid muscle is inserted from before; and the complexus obliquus and trachelomastoideus muscles from behind. It has been proposed of late years, that, in certain cases of deafness, we should open this part with the trepan.

The **AUDITORY PROCESS** is just the outer margin of the hole of the ear. It is in a child a distinct ring, which is laid upon the rest of the bone.* The membrane of the ear is extended upon this ring, like the head of a tambour upon its hoop, whence this is named the circle of the tambour by the French, and by us the drum of the ear. In the adult, this ring is fairly united to the bone, and is named the *processus auditorius*; and may be defined a circle, or ring of bone, with a rough irregular edge; the drum or membrane of the ear is extended upon it, and the cartilaginous tube of the ear is fixed to it; and this ring occupies the space from the root of the mamillary to the root of the zygomatic process.

Between this and the mastoid process there is a kind of fissure, the *rima mastoidea*.

The lower jaw is articulated with this bone by a shallow fossa, which is anterior to the auditory process, and at the root of the zygomatic process. A tubercle immediately before this articulating surface deepens it. A fissure may be observed in nearly the middle of the cavity, which is for the attachment of the ligament, which unites the intermediate cartilage of this articulation. This fissure divides the proper articular or glenoid cavity from that fossa which gives lodgement to a deep portion of the parotid gland.

HOLES. The temporal bone is perforated with many holes, each of which relates to the organ of hearing; some for permitting nerves to enter; others to let them out; others for the free passage of air to the internal ear.

The **MEATUS AUDITORIUS EXTERNUS** (the circle of which has been described) is covered with the membrane of the

* In brutes it is indeed a process standing out.

drum, and communicates the vibratory motion of the air for moving and exciting the internal organs.

The MEATUS AUDITORIUS INTERNUS is that hole by which the auditory nerves have access to the ear. It is a very large hole, seated upon the back of the pars petrosa, which is of a triangular form. The hole is at first large, smooth, almost a regular circle, with a sort of round lip. Within this are seen many small holes, the meaning of which is this: the auditory nerve is double from its very origin in the brain: it consists, in fact, of two distinct nerves, the portio dura, and the portio mollis. The portio mollis is a large, soft and delicate nerve, which constitutes the true organ of hearing; and when it is admitted into the ear, it is expanded into a thin web which spreads over all the cavities of the ear, as the cochlea, semi-circular canals, &c. The portio dura, the smaller part of the nerve, passes indeed through the ear, but it is quite a foreign nerve; it is not distributed within the ear; it keeps the form of a distinct cord, and, passing, through the temporal bone, it comes out upon the cheek, where it is expanded; so that the portio dura is a nerve of the face, passing through the ear, but forming no part of that organ. Thus the two nerves, the portio dura and mollis, enter together; they fill the greater hole, and then they part: the portio dura, entering by one distinct hole, takes its course along a distinct canal, the aqueduct of Fallopius from which it comes out upon the cheek; while the portio mollis, entering by many smaller holes into the cochlea, semi-circular canals, and other internal parts of the ear, is expanded in these cavities to form the proper organ of hearing.

There is a small hole which will admit the point of a pin upon the fore part of the petrous bone. This hole receives a small twig reflected from the fifth pair of nerves: the nerve is as small as a sewing thread; it can be traced along the petrous bone by a small groove, which conducts it to the hole; and when it enters the ear, it goes into the same canal with the portio dura, and joins itself to it.

The hole by which the portio dura passes out upon the cheek, is found just before the mastoid, and behind, the styloid process; and being betwixt the two, it is named the STYLO-MASTOID hole, and is so small, as just to admit a pin.

The hole for the Eustachian tube is very irregular. No air can pass through the membrane of the drum; and as air is necessary within the ear, it is conveyed upwards from the palate by the ITER A PALATO AD AUREM, or, as it is commonly called, the EUSTACHIAN TUBE. This tube is long, and of a trumpet form; its mouth, by which it opens behind the nostril, is wide

enough to receive the point of the finger, it grows gradually smaller as it advances towards the ear: it is cartilaginous in almost its whole length; very little of it consists of firm bone; so that the student, in examining the skull, will hardly find the Eustachian tube; for the cartilage being rotten away, nothing is left but that end of the canal that is next the ear, and which opens both above and below, ragged, irregular, and broken.

When we have a sore throat, the pain extends up along this tube into the ear; when we have a cold, both our voice and our hearing is hurt; the one by the stuffing of the sinuses, the other by the stuffing of the Eustachian tube. When we shut the nose and mouth, and blow strongly, we feel a crackling in the ear, as in the place of the Eustachian tube; when we dive, we feel the same, by the condensation of the air; and sometimes by forcing the air strongly upwards through the ear, or by vomits, obstruction of the Eustachian tube, and the deafness which attends that accident, are very suddenly, and, we may say, violently removed; or sometimes the cure is attempted by syringing, or by cleaning the mouth of this tube with a probe, just as we do the external ear.

Above and to the outside of the Eustachian tube there is a narrow canal which conveys the nerve called *corda tympani*. This nerve, traversing the tympanum, enters into the aqueduct of Falopius, and unites with the facial nerve.

On the inside of the Eustachian tube we may observe a canal which, leading backwards, opens into the cavity of the tympanum with a mouth like a spoon, it gives lodgement to the long muscle of the *malcus*.

The other holes do not relate to the ear, and are chiefly for transmitting the great blood vessels of the brain.

The CAROTID ARTERY, the chief artery of the brain, enters into the skull near the point of the petrous bone, and just before the root of the styloid process. The artery goes first directly upwards, then obliquely forwards through the bone, and then again upwards, to emerge upon the inside of the skull; so that the carotid makes the form of an Italic *S*, when it is passing through the substance of the bone; and, in place of a mere hole, we find a sort of short canal, wide, a little crooked, and very smooth within. There seems to be a particular design in this angle, which the artery is forced to make: perhaps it is designed to abate the violence with which the blood would drive forwards into the brain; for in many of the lower animals, there are still more particular provisions than this, the artery being prevented from entering the brain in one great trunk, by a curious division into many branches.

which meet again. It is at this particular point that we are sensible in our own body of the beating of these two great arteries; and Haller is at pains to inform us, that, during a fever, he felt this beating in a very distressing degree.

The GREAT LATERAL SINUS comes out in part through the temporal bone, to form the internal jugular vein. The course of the sinus may be easily traced by the groove of the occipital bone downwards, behind the pars petrosa: there also it makes a deep groove, and ends with a large intestine-like turn, which makes a large cavity in the temporal bone, big enough to receive the point of the finger. The sinus passes out, not by any particular hole in the temporal bone, but by what is called a COMMON HOLE, viz. formed one half by the temporal and one half by the occipital bone. This hole is very large; is lacerated or ragged-like. It is sometimes divided into two openings, by a small point, or spine of bone. The larger opening on one side of that point transmits the great sinus, where it begins to form the jugular vein; and the smaller opening transmits the eighth nerve of the skull, or par vagum, which goes down towards the stomach, along with the jugular vein.

There is a small furrow upon the very angle or ridge of the petrous bone, which is made by a small vein of the brain, the superior petrous sinus going towards the end of the lateral sinus.

There is a small hole on the outside of this bone, in the occipital angle; or rather the hole is oftener found in the line of the suture (the additamentum suturæ squamosæ). Sometimes, it is in the occipital bone; or sometimes it is wanting: it transmits a trifling vein from without, into the great sinus, or a small artery going to the dura mater.

There are two very small canals, which probably carry lymphatics from the inner cavities of the ear; they have been called aqueductus vestibuli, and aqueductus cochleæ; they open on the petrous bone, near the internal auditory foramen.

Among the irregular depressions on the different faces of this bone are sometimes enumerated these: the groove already mentioned on the mastoid process for the lodgement of the head of the digastricus; certain cerebral fossæ, which are the impressions of the convolutions of the brain upon the inside of the squamous portion; the jugular fossa, or thimble-like depression, made by the first turn of the great jugular vein; the temporal sinuosity for the lodgement of the temporal muscle; and, lastly, we observe in a well marked bone, the sulci for the artery of the dura mater.

THE ÆTHMOID BONE—Is perhaps one of the most curious bones of the human body. It appears almost a cube, not of solid bone, but exceedingly light, spongy, and consisting of many convoluted plates, which form a net-work like honey-comb. It is curiously enclosed in the os frontis, betwixt the orbitary processes of that bone. One horizontal plate receives the olfactory nerves, which perforate that plate with such a number of small holes, that it resembles a sieve, whence the bone is named cribriform, or æthmoid bone. Other plates, dropping perpendicularly from this one, receive the divided nerves, and give them an opportunity of expanding into the organ of smelling; and these bones, upon which the olfactory nerves are spread out, are so much convoluted, as to extend the surface of this sense very greatly, and are named spongy bones. Another flat plate lies in the orbit of the eye, which being very smooth, by the rolling of the eye, is named the os planum, or smooth bone; so that the æthmoid bone supports the forepart of the brain, receives the olfactory nerves, forms the organ of smelling, and makes a chief part of the orbit of the eye; and the spongy bones, and the os planum, are neither of them distinct bones, but parts of this æthmoid bone. Thus the æthmoid is united to the frontal bone, by the linea æthmoidea frontalis, and to the sphenoid bone by a similar line of contact, visible on the inside of the base of the cranium. Looking into the orbit, we again see a union with the frontal, and with the sphenoidal and palate bones. Its perpendicular plate stands connected to the back part of the nasal process of the frontal bone; the vomer is attached to the back part of this plate. The ossa unguis close the cells of this bone anteriorly.

The **CRIBRIFORM PLATE** is exceedingly delicate and thin, lies horizontally over the root of the nose, and fills up neatly the space betwixt the two orbitary plates of the frontal bone. The olfactory nerves, like two small flat lobes, lie out upon this plate, and, adhering to it, shoot down like many roots through this bone, so as to perforate it with numerous small holes, as if it had been dotted with the point of a pin, or like a nutmeg grater.

The plate is horizontal; but its processes are perpendicular, one above, and three below.

The first perpendicular process is what is called **CHRISTA GALLI**, a small perpendicular projection somewhat like a cock's comb, but exceedingly small, standing directly upwards from the middle of the cribriform plate, and dividing that plate into two; so that one olfactory nerve lies upon each side of the crista galli; and the root of the falx, or septum, betwixt the two hemispheres of the brain, begins from this process.

The foramen cæcum, or blind hole of the frontal bone, is formed partly by the root of the crista galli, which is very smooth, and sometimes, it is said, hollow or cellular.

Exactly opposite to this, and in the same direction with it, (*i. e.*) perpendicular to the æthmoid plate, stands out the NASAL PLATE of the æthmoid bone. It is sometimes called the azygous or single process of the æthmoid, and forms the beginning of that septum or partition which divides the two nostrils. This process is thin, but firm, and composed of solid bone; it is commonly inclined a little to one or other side, so as to make the nostrils of unequal size. The azygous process is united with the vomer, which forms the chief part of the partition; so that the septum, or partition of the nose, consists of this azygous process of the æthmoid bone above, of the vomer below, and of the cartilage in the fore or projecting part of the nose; but the cartilage rots away, so that whatever is seen of this septum in the skull, must be either of the æthmoid bone or the vomer.

The lateral parts of the æthmoid bone consists of a series of cells communicating with each other, and which are called the labyrinths. The cells of the labyrinth are closed by the external plate called os planum. These cells belong to the organ of smelling, and are useful by detaining the effluvia of odorous, bodies, and by reverberating the voice.

From each of these labyrinths there hangs down a SPONGY BONE, one hanging in each nostril. They are each rolled up like a scroll of parchment; they are very spongy; are covered with a delicate and sensible membrane, and when the olfactory nerves depart from the cribriform plate of the æthmoid bone, they attach themselves to the septum, and to these upper spongy bones, and expand upon them so, that the convolutions of these bones are of material use in expanding the organ of smelling, and detaining the odorous effluviæ till the impression be perfect. Their convolutions are more numerous in the lower animals, in proportion as they need a more acute sense. They are named spongy, or turbinated bones, from their convolutions, resembling the many folds of a turban.

The ORBITARY PLATE of the æthmoid bone is a large surface, consisting of a very firm plate of bone, of a regular square form, exceedingly smooth and polished: it forms a great part of the socket for the eye, lying on its inner side. When we see it in the detached bone, we know it to be just the flat side of the æthmoid bone; but while it is incased in the socket of the eye, we should believe it to be a small square bone; and from this, and from its smoothness, it has got the distinct name of os planum.

The *OS UNGUIS* should also, perhaps, be counted as a part of this bone; for though the *os unguis*, when observed in the orbit, seems to be a small detached bone, thin, like a scale, and of the size of the finger nail (whence it has its name,) yet in the adult the *os unguis* is firmly attached to the *æthmoid* bone, comes along with it when we separate the pieces of the skull, and when the *os unguis* is pared off from the *æthmoid* bone, it exposes the cells.

This *os unguis*, then, is a small scaly-like plate, in the inner corner of the orbit, just over the nose. We find in it that groove which holds the lachrymal sac, and conducts it to the nose; and it is this thin bone that we perforate in making the new passage into the nose, when there is an obstruction in the natural duct.

The cells of the *æthmoid* bone, which form so important a share of the organ of smell, are arranged in great numbers, along the spongy bone. They are small neat cells, much like a honey-comb, and regularly arranged in two rows, parted from each other by a thin partition; so that the *os planum* seems to have one set of cells attached to it, while another regular set of cells belong in like manner to the spongy bones. The cells are thus twelve in number,* opening into each other, and into the nose.

These cells are frequently the seat of venereal ulcers, and the spongy bones are the surface where polypi often sprout up. And from the general connections and forms of the bone, we can easily understand how the venereal ulcer, when deep in the nose, having got to these cells, cannot be cured, but undermines all the face; how the venereal disease, having affected the nose, soon spreads to the eye, and how even the brain itself is not safe. We see the danger of a blow upon the nose, which, by a force upon the septum, or middle partition, might depress the delicate cribriform plate, so as to oppress the brain with all the effects of a fractured skull, and without any operation which could give relief. And we also see much danger in pulling away polypi, which are firmly attached to the upper spongy bone.

SPHENOIDAL BONE.—The sphenoidal bone completes the cranium, and closes it below. It is named *SPHENOID CUNIFORM*, or *WEDGE-LIKE* bone, from its being incased in the very basis of the skull; or it is named *OS MULTIFORME*, from its irregular shape. It is united to fourteen distinct bones. It is much of the shape of a bat, whence it is often named the

* The number is commonly twelve, but not regularly so.

PTERYGOID BONE, its temporal processes being like extended wings; its proper pterygoid processes like feet; its middle like the body and head of a bat; its wing-like processes, are in the hollow of the temple, forming a part of the squamous suture, and also composing a part of the orbit of the eye. Its pterygoid processes hang over the roof of the mouth, forming the back of the nostrils: the body is in the very centre of the skull, and transmits five of the nerves from the brain, besides a reflected nerve; but still the body bears so small a proportion to the bone, that we have not a regular centre to which all the processes can be referred; so that we are always, in describing this bone, moving forwards from point to point, from one process or hole to the next.

PROCESSES.—The **ALÆ**, or **WINGS**, often named temporal processes, rise up in the temple, to form part of the hollow of the temple; and the wings of the sphenoid bone meeting the frontal, parietal, and temporal bones, by a thin scaly edge, they make part of the squamous suture, and give a smooth surface for the temporal muscle to lay upon.

The other side of this same process looks towards the socket of the eye, and has a very regular and smooth surface; it is opposite to the *os planum*. As the *æthmoid* bone forms part of the inside of the orbit, the wing of the sphenoid bone forms part of the outside of the orbit: and so the surface turned towards the eye is named the **ORBITARY PROCESS** of the sphenoid bone, or **ORBITARY PLATE** of the great ala.

The surface of the great wing which looks backwards, receives the middle lobe of the cerebrum and is called the **CEREBRAL FOSSA**; and that which is external and receiving the temporal muscle, is called the temporal fossa.

The lower, or back part of this bone runs out into a narrow point, which sinks in under the petrous portion of the temporal bone, and being sharp pointed, it is named the **SPINOUS PROCESS**. It is very remarkable for a small hole which permits the great artery of the *dura mater* to enter.

The point of this spinous process projects in the form of a very small peak, which will hardly be found by the student. It projects from the basis of the skull just within the condyle of the lower jaw, and being a small point, like the point of the stylus, or iron-pen, it also is named **STYLOID PROCESS**.

The **LESSER WING OF INGRASIAS** next attracts the eye. It is that part of the bone which unites (by *harmonia*) with the orbitary plate of the frontal bone, and with the *æthmoid* bone.

This lesser wing projects laterally into the **TRANSVERSE SPINOUS PROCESS**.

The **PTERYGOID PROCESSES*** are four in number, two on either side. They are those processes, upon which (with the spinous process) the bone naturally stands, and which, when we compare it with a bat, represent the legs; one of each side, is named external pterygoid, the other is named the internal pterygoid process.

Each **EXTERNAL PTERYGOID PROCESS** is thin and broad, and extends farther backwards. Each **INTERNAL PTERYGOID PROCESS** is taller and more slender, and not so broad. It has its end rising higher than the other, and tipped with a small neat hook, named the hook of the pterygoid process, (viz. the **HAMULAR PROCESS**.) The inner pterygoid processes, form the back of the nostrils. The hook of the pterygoid process, is called the hook of the palate, of which it forms the backmost point. The *musculus circumflexus vel tensor palati*, rising from the mouth of the Eustachian tube, turns with a small tendon round this hook, like a rope over its pulley; and the great muscles of the lower jaw, the only ones for moving it sideways, or for its grinding motions, arise from the pterygoid processes. Between the two processes there is a hollow which is called the *fossa pterygoidea*.

The **AZYGOUS PROCESS,†** is so named, from its being single, because it is seated in the centre of the bone, so that it can have no fellow. It stands perpendicularly downwards, and forwards, over the centre of the nose, and its chief use is to give a firm seat or insertion for the vomer or bone which forms the septum. The vomer, or proper bone of the partition, stands with a split edge, astride over this process, so as to have a very firm seat. A kind of union which has been called *gomphosis*.

The **CLYNOID PROCESSES** have, like many parts of the human body, a very whimsical name, very ill suited to express their form; for it is not easy, in this instance, to acknowledge the likeness of four little knobs to bed-posts; yet the clynoid processes are very remarkable. The two **ANTERIOR CLYNOID PROCESSES** are small bumps, rather sharp, projecting backwards, and terminating in two flat projecting points. The **POSTERIOR CLYNOID PROCESSES** rise about an inch farther backwards, and are, as it were, opposed to the others. They rise in one broad and flat process, which divides above into

* There is some confusion in this name, since pterygoid signifies aliform, or wing-like processes.

† Azygous is a term, which is applied to such parts as have no fellow; because almost always the parts on one side of the body are balanced by similar and corresponding parts on the other side. When they stand in the centre of the body, or are otherwise single, we call them azygous, and so the azygous process of the æthmoid and sphenoid, and other bones; or the azygous vein, which runs in the centre of the thorax, and is single.

two points, small and round, or nobby at their points; and they look forwards towards the anterior clynoid processes.

The *TUBERCULUM OLIVARE* is an eminence betwixt the anterior clynoid process and before the *sella turcica*.

The *SELLA TURCICA EPhippium*, or Turkish saddle, is the space enclosed by these four processes, and is well named. The *sella turcica*, supports the pituitary gland, an appendage of the brain, the use of which is unknown. The carotid arteries rise up by the sides of the *sella turcica*, and mark its sides with a broad groove. The optic nerves lie upon a groove at the fore part of the *sella turcica*, betwixt the two anterior clynoid processes; and sometimes the two anterior processes stretch backwards, till they meet the posterior ones, and form an arch, under which the carotid artery passes. Often the posterior clynoid knobs cannot be fairly distinguished; since, in many skulls, they form but one broad process.

On the side of the posterior clynoid process, the carotid artery as it rises impresses its form upon the bone.

The cone or triangular process is singularly placed in obscurity, when the bones are in union, and in separating the sphenoid bone it is very apt to be broken off. This process closes the cell, and projects laterally towards the deepest part of the orbit, but so as to be concealed by the palate bone.

This bone has also its cells, for all that part which we call the body of the bone, all the *sella turcica*, that space which is betwixt the clynoid processes within and the azygous process without, is hollowed into one large cell, divided with a middle partition. It is, indeed, less regular than the other cells; it is sometimes very large, sometimes it is not to be found; it has other trifling varieties which it were idle to describe. As it communicates with the æthmoid cells, it probably performs one office with them, is almost a continuation of them, so that when any one is less or wanting, the others are proportionally larger.

HOLES.—The sphenoid bone is so placed in the very centre of the skull, that its holes transmit the principal nerves of the skull, and it bears the marks of the chief arteries.

The **OPTIC HOLES** are large round holes, just under each anterior clynoid process. We trace the optic nerves by a large groove into each optic hole; and an artery goes along with them, named the ophthalmic artery, nearly the size of a crow-quill, twisting round the optic nerve, and giving arteries to the eye-lids, muscles, and lachrymal gland, but most especially to the ball and humours of the eye itself. This ocular or ophthalmic artery comes off from the great carotid, while it lies by the side of the *sella turcica*; and it is a branch again

of this ocular artery, which goes out upon the forehead, through the superciliary notch, or hole.

The FORAMEN LACERUM, is next in order, and is so named, because it is a wide slit. It is also called superior orbitary fissure. The foramen lacerum is wide near the sella turcica, grows gradually narrower as it goes out towards the temple, till it terminates almost in a slit. The upper line of the foramen lacerum is formed by the transverse spinous process, extending outwards, sharp and flat.

The nerves of the skull are counted from before backwards. There are nine nerves, proper to the skull; the 1st, or olfactory nerve, perforates the cribriform bone; the 2d, or optic nerve, passes through the optic hole; the 3d, 4th, part of the 5th and 6th pairs of the nerves, pass through this foramen lacerum, or wide hole, to go also into the orbit. The optic nerve forms the proper organ of vision. The smaller nerves of the 3d, 4th, 5th, and 6th pairs, go to animate its muscles, and passing through the orbit, to mount upon the forehead, or go downwards into the nose.

The FORAMEN ROTUNDUM is named from its round shape. The foramen opticum is indeed round, but it has already got an appropriated name. Now to give the young anatomist a regular notion of this, and of the next hole, we must enumerate the branches of the 5th pair. The fifth nerve of the brain is as broad as the little finger, and lies by the side of the sella turcica, where it divides into three lesser nerves, which are called branches of the 5th pair. The first branch of the 5th pair is destined for the eye; the second branch of the 5th pair for the upper jaw; the third branch of this 5th pair for the lower jaw: so the first branch of this 5th pair passes through the foramen lacerum to the eye; the second branch of the 5th pair passes through the foramen rotundum to the upper jaw; the third branch of this great nerve passes through the foramen ovale to the lower jaw; and if we had any faith in the doctrines of nervous sympathy, we should say, here is a wide sympathy provided among the nerves of the eye, the face, and the lower jaw.

The foramen rotundum then, is a hole exactly round, pretty large, opening immediately under the inner end of the foramen lacerum, and transmitting the second branch of the 5th pair of nerves to the upper jaw.

The FORAMEN OVALE is an oval hole, larger than the foramen rotundum; about half an inch behind it; and transmitting the third branch of the 5th pair to the lower jaw.

The FORAMEN SPINALE, or SPINOUS HOLE, is a very small round hole, as if made with a large pin; is in the very point

of the spinous process : is one third of an inch behind the oval hole, and transmits the small artery, less than a crow-quill, which constitutes the chief artery of the dura mater, viz. that artery which makes its impression upon the parietal bone.

There is still another hole, which transmits a nerve, curious in this respect, that it is not going out from the skull but returning into it ; for the second branch of the 5th pair, or the superior maxillary nerve, sends a small branch backwards, which having come within the skull, enters the temporal bone, and goes to join itself to the portio dura of the 7th pair, and in its way, gives a small branch, to help out the slender beginning of the great sympathetic nerve. This retrograde branch of the maxillary nerve gets back again into the skull, by a hole which is found just under the root of each pterygoid process, whence it is named PTERYGOID HOLE :* or by many, is named after its discoverer, the VIDIAN HOLE.† This hole is almost hidden under the point of the petrous bone, is not to be seen unless in the separated bones, and is nearly of the size of the spinous hole.

If there are found some minute holes about the sella turcica, they are the marks of some blood vessels entering the bone to nourish it.

When the bones of the cranium are united, there is apparent an irregular hole, which corresponds well with the name foramen lacerum medius. It is the continuation of the carotid foramen, but belongs equally to the sphenoid, temporal, and occipital bones. The petrous portion of the temporal bone points to it.

There is a second common hole formed betwixt the sphenoid, the maxillary, and the cheek-bone. It is called the spheno-maxillary fissure.

There is a third common hole betwixt the cell of the palate-bone (in the separate bone a groove may be noticed on the back part of this cell,) and the root of the pterygoid process. This hole transmits an artery, and a twig of the 5th pair of nerves, into the membrane of the nose.

* This retrograde twig is the little nerve, which perforates the os petrosum on its forepart.

† Vidus Vidius, a professor of Paris, and physician to Francis the First.

CHAP. IV.

OF THE BONES OF THE FACE AND JAWS.

THE face is composed of a great number of small bones, which are grouped together, under the common name of upper-jaw. There are six bones on either side of the face; but as their names could convey no distinct notion of the uses, forms, or places of these bones, to enumerate them were but waste of time; they have indeed sutures, and their sutures have been very regularly enumerated; but these bones meet each other by such thin edges, that no indentation nor proper suture is formed. None of these sutures run for any length, or are of any note, therefore I have only this to say, concerning the sutures of the face, that they are acknowledged to be purely a consequence of the ossification having begun in many points: no particular design of nature has been supposed. The sutures, if they require names, are to be named after the bones which they unite together.

OSSA NASI.—The ossa nasi are small bones, rather thin, having no cancelli, being merely firm and condensed plates. They are convex outwardly, so that the two together form nearly an arch. They are opposed to each other by a pretty broad surface, so that their thin arch is firm. They have a flat rough surface, by which they are laid upon the rough surface of the frontal bone; so that there also their connection is strong. They are enclosed by a branch of the upper jaw-bone, which, stretching upwards, is named its nasal process: and they lie with their edges under it in one part, and above it in another, in such a way that they cannot easily be forced in. Lastly, their lower edge is rough, for the firm attachment of the cartilages of the nose; and their lowest point, or that where the bones of the nose and the gristles of the nose are joined, is the most prominent point (or, as it is vulgarly called, the bridge) of the nose; from which connection, notwithstanding its firmness, the cartilages are sometimes luxated.

The only point like a process in these bones, is that rough ridge formed by their union which projects towards the cavity to give attachment to the nasal plate of the æthmoid bone.

Os **UNGUIS**, so named from its being of the size and shape of the nail; or sometimes named the Os **LAGHRYMALE**, from its holding the duct which conveys the tears, is that thin scale of bone which I have described as belonging to the os æth-

moides. It is commonly described as a distinct bone; it is a thin flat bone, a single scale, without any cancelli, having only one sharp ridge upon it; it forms a groove for lodging the lachrymal sac, and is of course found in the inner angle of the eye at its forepart, and just touching the top of the nose. One half of this bone is behind the groove, and there the eye rolls upon it. One half of it is occupied by the groove for the nasal duct; and the other side of the groove is formed by the rising branch or nasal process, as it is called, of the upper jaw-bone. The *os unguis* is delicate, and easily broken, being as thin as a sheet of paper. It is this bone which is pierced in the operation for the fistula lachrymalis, which is easily done, almost with a blunt steel or probe; and the chief caution is to perforate in the place of the groove, as that will lead into the nose, and not behind it, which would carry the perforating instrument into the æthmoidal sinuses, and perhaps wound the spongy bone; nor more forward, as that would be ineffectual from the strength of the nasal process of the maxillary bone.

This bone seems peculiarly liable to caries, which is perhaps the nature of all these thin bones; for as they have no marrow, they must depend entirely on their periosteum for their blood vessels, which they are no sooner robbed of than they die.

OSSA MAXILLARIA SUPERIORA.—The upper jaw-bones are particularly worthy of notice; for here we find all that is curious in the face, even to its size and shape. The upper jaw-bones are of a very great size, forming, as it were, the foundation or basis of the face. They send a large branch upwards which forms the sides of the nose; a broad plate goes backwards, which forms the roof of the palate. There is a circular projection below which forms the alveoli, or sockets of the teeth. The upper jaw bones are quite hollow within, forming a very large cavity, which is capable of containing an ounce of fluid, or more; and the size of this cavity seems to determine the height of the cheek bone and the form of the face; and the diseased enlargement of this cavity raises the cheek bone, lessens the eye, and deforms the face in a very extraordinary degree.

These processes, and this cavity of the bone, are what deserve most particular notice.

The surfaces or plates of the bone, are these: External or *malar* surface; The superior or *orbital*; The internal or *nasal*; The inferior or *palatine*.

From this description we shall understand the connections of the bone. It is attached forward and upward to the nasal and frontal bones. Laterally to the cheek-bone, and in the

orbit it is connected with the lachrymal and æthmoid bones ; towards the nasal cavities, it has the vomer palate-bone and lower spongy bones attached to it, and at the back part it touches the sphenoid bone.

The first process is the NASAL PROCESS, which extends upwards to form the side of the nose. It is arched outwards, to give the nostrils shape. Its sides support the nasal bones ; and the cartilages of the alæ nasi, or wings of the nose, are fixed to the edges of this process. On the inside and root of the nasal process there is a rough horizontal ridge, which gives attachment to the forepart of the inferior spongy bone.

A plate of this bone is called the orbitary process. This thin plate is the roof of the great cavity, which occupies this bone entirely. It is at once as a roof to the antrum maxillare, and as a floor for the eye to roll upon. There is a wide groove along the upper surface of this plate, in which the chief branch of the upper maxillary nerve lies : and this nerve, named infra-orbitary nerve, from its lying thus under the eye, comes out by a hole of the jaw-bone under the eye, which is named infra-orbitary hole. And thus the nerve appearing upon the cheek, becomes a nerve of the face.

This great bone is the basis upon which the cheek-bone stands ; and that it may have a firm place, there is a rough and (as anatomists call it) scabrous surface, which makes a very firm suture with the cheek-bone ; and as this surface rises a little, it is named the MALAR PROCESS.

From the lower circle of the upper bone, there projects a semi-circle of bone, which is for lodging the teeth of the upper jaw. This circle of bone is as deep as the fangs of the teeth are long. And it may be very truly named a process (PROCESSEUS ALVEOLARIS,) since it does not exist in the fœtus, nor till the teeth begin to be formed ; since it grows along with the teeth, and is absorbed and carried clean away when in old age the teeth fall out. The sides of the sockets in which the teeth are lodged are extremely thin, and surround them closely. The teeth are so closely embraced by their sockets, and we are so far from being possessed of any instrument by which they can be pulled perpendicularly out, that the sockets can seldom escape ; they are broken or splintered in perhaps one of four extractions, even by the most dexterous artists in that line.

The PALATE PROCESS is a plate of bone which divides the nose from the mouth, constituting the roof of the palate, and the floor or bottom of the nostrils. This plate is thinner in its middle, and thicker at either edge : thus, it is thick where it first comes off from the alveolar process ; it is thin in its

middle ; and it is again thick where it meets its fellow of the opposite side. For at the place where the two upper jaw-bones meet, the palate-plate is turned upwards, so that the two bones are opposed to each other in the middle of the palate by a broad flat surface, which cannot be seen but by separating the bones. This surface is so very rough that the middle palate suture almost resembles the sutures of the skull ; and the maxillary bones are neither easily separated, nor easily joined again. This meeting of the palate-plates by a broad surface, makes a rising spine, or sharp ridge, towards the nostrils, so that the broadness of the surface by which these bones meet, serves a double purpose ; it joins the bones securely, and it forms a small ridge upon which the split edge of the vomer, or partition of the nose, is planted. Thus we find the palate-plate of the maxillary bones conjoined, forming almost the whole of the palate, while what are properly called the palate-bones, form a very small share of the back part only. As these thinner bones of the face have no marrow, they are nourished by their periosteum only ; they are of course perforated with many small holes. A great many minute holes are found along the palate-plate, about the place of the sockets, and indeed all over the maxillary bones ; and this is particular in the palate, that the hard membrane, or covering of it, is fixed to the bony plate by many rough tubercles, and even by small hooks, which are easily found in the dried bone.

Since we are describing the plates of the bone as processes, we ought to enumerate the *facies interna nasalis* as an INTERNAL NASAL PALATE. This is the side of the bone which is towards the cavity of the nose, on which the lower spongy bone hangs, and which is perforated to allow a communication betwixt the great cell and the nose.

The ANTRUM MAXILLARE, or cavity of the jaw-bone, is commonly named ANTRUM HIGHMOREANUM, after its discoverer, Highmore. We have gone round the antrum on all its sides, in describing these processes of the bone : the palate-plate makes the floor of the antrum ; the orbitary process makes its roof ; the cheek quite up from the sockets of the teeth to the lower part of the eye, forms its walls or sides : so that when the antrum enlarges, it is the cheek that becomes deformed ; and when we design to open the antrum, we either perforate the cheek, or pull one of the teeth. The antrum is round towards the cheek, but it has a flat side towards the nose ; it is divided from the cavity of the nostril by a flat and very thin plate of bone ; it seems in the naked skull to have a very wide opening ; but in the skull, covered with its soft parts, we find the antrum almost closed by a membrane which stretches over

the opening, and leaves but one or two very small holes, of the size of the smallest pea, by which, perhaps, the reverberation of sound in the antrum is more effectual in raising the voice, and by which small hole, the mucus, which is secreted in the antrum, drops out into the nose. The cavity of the antrum, like the inner surfaces of the nostrils, is covered with a membrane, and is bedewed with mucus; and the mucus drops more or less freely in various positions of the head. Sometimes by cold or other accidents, inflammations and swellings of the membrane come on; the holes are closed; the drain of matter is suppressed and confined within, and the cheek swells. Perhaps there may be some particular disease of the membrane with which the cavity is lined, or of the bone itself: in one way or other, diseases of this cavity, and collections of matter, dreadful pain and caries of the bone, are very frequent: then the cheek rises; the face is irrecoverably deformed. Sometimes the matter makes its way by the sides of the teeth, or at last it bursts through the bones, makes an ulcer in the cheek; and then there is a natural cure, but slow and uncertain. There is no very sure mark of this disease; it may be known by an attentive retrospect of all the circumstances. The disease is not to be easily nor certainly discovered; but a very long continued tooth-ache, an uncommon degree of pain or greater affection of the eye, with a swelling and redness and gradual rising of the cheek, are very suspicious signs. The pulling of the second or third of the grinding teeth, often brings a splinter away with it, which opens a road for the matter to flow; or though there be no breach of the socket, often the confined matter follows the tooth, because not unfrequently the longer fangs of the grinders naturally penetrate quite into this cavity of the jaw: if the matter should not flow, the floor of the antrum is easily perforated, by introducing a sharp stillet by the socket of the tooth that is pulled. The flow of the matter gives relief, and injections complete the cure. But as this opening is sometimes a cure, it is sometimes also a disease; for the breaking of a socket, sometimes opening a way into this antrum, there follows inflammation of its internal surface, a running of matter, and sometimes caries of the bone.

HOLES.—There is only one perfect hole in this bone; but, by its union with other bones, it forms four more: The **INFRA-ORBITARY** hole, for transmitting the infra-orbitary nerve from the bottom of the eye, is the opening of the canal which comes along under the eye. It is just under the margin of the orbit, or sometimes the nerve which it transmits, divides, and makes two smaller holes in its passage upon the cheek. A

hole in the palate-plate, which belongs equally to each of the palate-bones may be counted the second foramen ; for it is betwixt the two bones in the fore part, or beginning of the palate-suture behind the two first cutting teeth. This hole is named *FORAMEN INCISIVUM*, as opening just behind the incisive or cutting teeth ; or it is named *ANTERIOR PALATINE HOLE*, to distinguish it from one in the back of the palate. This hole is large enough to receive the point of a quill ; it is single towards the mouth ; but towards the nose, it has two large openings, one opening distinctly into each nostril.

But it will be well to explain here a third hole, which is common to the maxillary, with the proper palate-bones. It is formed on the back part of the palate (one on either side,) in the suture which joins the palate-bones to the jaw-bones : it is named *POSTERIOR PALATINE HOLE* : It is as large as the anterior palatine hole, but it serves a much more important purpose ; for the upper maxillary nerve sends a large branch to the palate, which branch comes down behind the back of the nostril, perforates the back of the palate by the posterior palatine hole, and then goes forward in two great branches along the palate. Thus the chief, or, we might say, the only nerves of the palate comes down to it through these posterior palatine holes. The use of the anterior palatine hole has long been a problem. It looks almost as if it were merely designed for giving the soft palate a surer hold upon the bone ; but Scarpa, the Italian anatomist, describes a nerve from the 5th pair, taking its course in this way to the soft palate.

The fourth foramen is formed by the union of the lower spongy bone, to the internal nasal plate of the bone ; and is for the transmission of the lachrymal duct.

The *LATERAL ORBITARY FISSURE*, called also *SPHENO MAXILLARY FISSURE*, is a slit formed by this bone and the sphenoid bone ; it is a communication betwixt the orbit and temple.

The whole surface of the bone which forms the antrum is perforated with frequent small holes, especially towards its back part, transmitting small arteries and nerves to the teeth ; and the back part of the antrum forms with the orbitary part of the sphenoid bone a second foramen lacerum for the orbit, which is an irregular opening towards the bottom of the socket, and is for the accumulation of fat, rather than for the transmission of nerves ; and it is from the wasting of this fat, taken back into the system, that the eye sinks so remarkably in fevers, consumptions, and such other diseases as waste the body. At the termination of the alveolar circle, backwards, there are two or three holes, into which the branches of the internal maxillary artery enter, which go to supply the teeth

of the upper jaw. There is a trifling hole for the transmission of an artery on the nasal plate of this bone.

The **OSSA PALATI**, or **PALATE BONES**—are very small, but have such a number of parts, and such curious connections as are not easily explained. They seem to eke out the superior maxillary bones, so as to lengthen the palate, and complete the nostrils behind: they even extend upwards into the socket, so as to form a part of its circle; although, in looking for them upon the entire skull, all these parts are so hidden, that we should suppose the palate-bones to be of no greater use nor extent than to lengthen the palate a little backwards.

The parts of the palate-bone are these:

The **PALATAL PLATE**, or process of the palate-bone, whence it has its name, lies horizontal in the same level with the palatal process of the jaw-bone, which it resembles in its rough and spinous surface; in its thinness; in its being thinner in the middle, and thicker at either end; in its being opposed to its fellow by a broad surface, which completes the **MIDDLE PALATE SUTURE**; and it is connected with the palate process of the jaw, by a suture resembling that by which the opposite bones are joined; but this suture, going across the back part of the palate, is named the **TRANSVERSE PALATE SUTURE**. Where the two palate-bones are joined, they run backwards into an acute point; on either side of that middle point, they make a semi-circular line, and again run out into two points behind the grinding teeth of each side. By this figure of the bones, the back line of the palate has a scolloped or waved form. The **velum palati**, or curtain of the palate, is a little arched, following the general line of the bones; the uvula, or pap, hangs exactly from the middle of the velum taking its origin from the middle projecting point of the two bones; and a small muscle, the **azygus uvulæ**, runs down in the middle of the velum, taking its origin from this middle.

The small projecting point of the palate-bone, just behind the last grinding tooth, touches the pterygoid process of the sphenoid bone, it is therefore named the **PTERYGOID PROCESS** of the palate-bone: but it is so joined with the pterygoid process of the sphenoidal bone, that they are not to be distinguished in the entire skull. The posterior pterygoid hole, or third hole of the palate, is just before this point.

The **NASAL PLATE**, or **PROCESS**, is a thin and single plate; rises perpendicularly upwards from the palate; lies upon the side and back part of the nostrils, so as to form their opening backwards into the throat; it is so joined to the upper jaw-

bone, that it lies there like a sounding-board upon the side of the antrum Highmorianum, and completes that cavity forming the thin partition betwixt it and the nose.

This nasal process extends thus up from the back arch of the palate to the back part of the orbit; and, though the nasal plate is very thin and delicate in its whole length, yet, where it enters into the orbit, it is enlarged into an irregular kind of knob of a triangular form. This knob is named its ORBITARY PROCESS; or, as the knob has two faces looking two ways in the orbit, it is divided sometimes (as by Monro the father,) into two orbitary processes, the anterior and posterior; the anterior one is the chief. This orbitary process, or point of the palate-bone, being triangular, very small, and very deep in the socket, is not easily discovered in the entire skull.

This orbitary process is most commonly hollow or cellular, and its cells are so joined to those of the sphenoid bone, that it is the palate-bone that shuts the sphenoid cells, and the sphenoid and PALATINE CELLS of each side constitute but one general cavity.

On the inside of the nasal plate of this bone, we may perceive a ridge corresponding with that on the nasal process of the maxillary bone, and which is for giving attachment to the lower spongy bone.

The OSSA SPONGIOSA, or TURBINATA INFERIORA, are so named, to distinguish them from the upper spongy bones, which belong to the æthmoides; but these lower spongy bones, are quite distinct, formed apart, and connected in a very slight way with the upper jaw-bones.

The OSSA SPONGIOSA INFERIORA are two bones, much rolled or convoluted, very spongy, much resembling puff-paste, having exactly such holes, cavities, and net-work, as we see in raised paste, so that they are exceedingly light. They lie rolled up, in the lower part of the nose; are particularly large in sheep; are easily seen either in the entire subject or in the naked skull. Their point forms that projection which we touch with the finger in picking the nose; and from that indecent practice, very often serious consequences arise; for in many instances, polypi of the lower spongy bones, which can be fairly traced to hurts of this kind, grow so as to extend down the throat, causing suffocation and death.

One membrane constitutes the universal lining of the cavities of the nose, and the coverings of all the spongy bones. This continuity of the membrane prevents our seeing in the subject how slightly the spongy bones are hung: but in the bare and dissected skull we find a neat small hook upon the spongy

bones, by which it is hung upon the edge of the antrum maxillare; for this lower spongy bone is laid upon the side of the antrum, so as to help the palate-bone in closing or covering that cavity from within. One END of the spongy bone, rather more acute, is turned towards the opening of the nostril, and covers the end of the lachrymal duct: the other END of the same bone points backwards towards the throat. The curling plate hangs down into the cavity of the nostril, with its arched side towards the nose. This spongy bone differs from the spongy process of the æthmoid bone, in being less turbinated or complex, in having no cells connected with it, and perhaps it is less directly related to the organ of smell. If polypi arise from the upper spongy bone, we can use less freedom, and dare hardly pull them away, for fear of injuring the cribriform plate of the æthmoid bone. We are indeed not absolutely prohibited from pulling the polypi from the upper spongy bone; but we are more at ease in pulling them from the lower one, since it is quite an insulated bone. When peas, or any such foreign bodies, are retained in the nose, it must be from swelling, and being detained, among the spongy bones.

The spongy bones are not absolutely limited in their number; there is sometimes found betwixt these two a third set of small turbinated bones, commonly belonging to the æthmoid bone.

VOMER.—The nose is completed by the vomer, which is named from its resemblance to a plough-share, and which divides the two nostrils from each other: It is a thin and slender bone, consisting evidently of two plates, much compressed together, very dense, and strong, but still so thin as to be transparent. The two plates of which the vomer is composed split or part from each other at every edge of it, so as to form a groove on every side. 1. On its upper part, or, as we may call it, its base, by which it is fixed to the skull, the vomer has a WIDE GROOVE, receiving the projecting point of the æthmoid and sphenoid bones: thus it stands very firm and secure, and capable of resisting very violent blows. 2. Upon its lower part its groove is narrower, and receives the rising line in the middle of the palate-plate, where the bones meet to form the palate suture. At its forepart it is united by a ragged surface, and by something like a groove to the middle cartilage of the nose; and, as the vomer receives the other bones into its grooves, it is in a manner locked in on all sides: it receives support and strength from each; and if the vomer and its cartilage should seem too slender a support, for the fabric of the nose, let it be remembered, that they are

all firmly connected, and covered by one continuous membrane, which is thick and strong, and that this is as a periosteum, or rather like a continued ligament, which increases greatly the thickness and the strength of every one of these thin plates. The vomer, in almost every subject, bends much towards one or other nostril, so as sometimes to occasion no small apprehension, when it happens to be first observed.

OS MALÆ, or the bone of the cheek, is easily known. It is that large square bone which forms the cheek: it has four distinct points, which anatomists have chosen to demonstrate with a very superfluous accuracy. The **UPPER ORBITARY PROCESS** stands highest, running upwards to form part of the socket, the outer corner of the eye, and the sharp edge of the temple. The **INFERIOR ORBITARY PROCESS**, which is just opposite to this, forming the lower part of the orbit and the edge of the cheek. The **MAXILLARY PROCESS** is that broad and rough surface, by which it is joined to the upper jaw-bone. The one the best entitled to the name of process, because it stands out quite insulated, and goes outwards and backwards to unite with the temporal bone, forming the zygoma or temporal arch, is named the **ZYGOMATIC PROCESS**. The plate, which goes backwards to form a part of the orbit, is named the **INTERNAL ORBITARY PROCESS**. A small hole is observed on the outer surface of the bone which transmits an artery, and sometimes a very small nerve from the orbit.

OS MAXILLÆ INFERIORIS.—The lower jaw-bone is likened to a horse shoe, or to a crescent, or to the letter U, though we need be under no anxiety about resemblances, for a form so generally known. There is such an infinite complication of parts surrounding the jaw, of glands, muscles, blood-vessels, and nerves, that it were endless to give even the slightest account of these. They shall be reserved each for its proper place, while I explain the form of the lower jaw, in the most simple and easy way. The lower jaw is divided into the chin, viz. the space betwixt the two mental foramina; the base, properly the sides, extending backward to the angle; and the upright portion of the bone.

The forepart, or chin, is, in a handsome and manly face, very square; and this portion is marked out by this squareness, and by two small holes, one on either side, by which the nerves of the lower jaw come out upon the face.

The base of the jaw is a straight and even line, terminating the outline of the face. It is distinctly traced all along, from the first point of the chin, backwards to the angle of the jaw. Fractures of this bone, are always more or less transverse, and are easily known by the falling down of one part of this even

line, and by feeling the crashing bones when the fallen part is raised. Such fractures happen from blows or falls ; but not by pulling teeth, for the sockets of the teeth bear but a small proportion to the rest of the jaw ; even in children this cannot happen ; for in them the teeth have shorter roots, and have no hold nor dangerous power over the jaw : though (as I have said) the sockets often suffer, the jaw itself never yields.

The angle of the jaw is that corner where the base of the jaw ends, where the bone rises upwards, at right angles, to be articulated with the head. This part, also, is easily felt, and by it we judge well of the situation of veins, arteries, and glands which might be in danger of being cut, in wounds or in operations. There are two processes of the jaw of particular importance, the coronoid or horn-like process, for the insertion of its strong muscles, especially, of the temporal muscle, and the condyloid or hinge process, by which it is joined with the temporal bone.

The CORONOID PROCESS, named from its resemblance to a horn, is, like the rest of the jaw-bone, flat on its sides, and turned up with an acute angle, very sharp at its point, and when the bone is in its place, lying exactly under the zygoma or temporal arch. The temporal muscle runs under this arch, and lays hold on the coronary process, not touching it on one point only, but grasping it on every side, and all round. And the process is set so far before the articulation of the jaw, that it gives the muscle great power. This process is so defended by the temporal arch, and so covered by muscles that it cannot be felt from without.

The CONDYLOID PROCESS, or the articulating process of the jaw is behind this. This also is of the same flat form with the rest of the jaw. The condyle, or joint of the jaw-bone, is placed upon the top of the rising branch. The condyle, or articulating head, is not round, but flat, of a long form, and set across the branch of the jaw. This articulating process is received into a long hollow of the temporal bone, just under the root of the zygomatic process ; so that by the long form of the condyles, and of the cavity into which it is received, this joint is a mere hinge, not admitting of lateral nor rotatory motions, at least of no wider lateral motions than those which are necessary in grinding the food ; but the hinge of the jaw is a complex and very curious one, which shall be explained in its proper place. The line of continuation between these two last processes forms what is called the semi-lunar notch.

The ALVEOLAR PROCESS, or the long range of sockets for the teeth, resembles that of the upper jaw. The jaw, as the body grows, is slowly increasing in length, and the teeth are

added in proportion to the growth of the jaws. When the jaws have acquired their full size, the sockets are completely filled; the lips are extended, and the mouth is truly formed. In the decline of life the teeth fall out, and the sockets are re-absorbed, and carried clean away, as if they had never been; so that the chin projects, the cheeks become hollow, and the lips fall in, the surest marks of old age.

The *SPINA INTERNA*, or internal tubercle of the lower jaw, is just behind the symphysis, or on the inside of the circle of the chin. It gives origin to muscles which move the tongue and larynx. On the inside of the lateral portion of the jaw, we observe an oblique ridge for the attachment of the mylo-hyoideus. On the inside of the angle, the bone is rough for the attachment of the pterygoid muscle.

The successive changes of the form of the jaw are worthy of being mentioned once more; first, that in the child the jaw consists of two bones, which are joined slightly together in the chin. This joining, or symphysis, as it is called, is easily hurt, so that in preternatural labours it is, according to the common method of pulling by the chin, always in danger, and often broken. During childhood the processes are blunt and short, do not turn upwards with a bold and acute angle, but go off obliquely from the body of the bone. The teeth are not rooted, but sticking superficially in the alveolar process; and another set lies under them ready to push them from the jaws.

Secondly, That in youth the alveolar process is extending, the teeth are increasing in number. The coronoid and articulating processes are growing acute and large, and are set off at right angles from the bone. The teeth are now firmly rooted; for the second set has come up from the body of the jaw.

Thirdly, In manhood the alveolar process is still more elongated. The *dentes sapientiæ* are added to the number of the teeth; but often, by this, the jaw is too full, and this last tooth coming up from the backmost point of the alveolar process in either jaw, it sometimes happens that the jaw cannot easily close; the new tooth gives pain; it either corrupts, or it needs to be drawn.

Fourthly, In old age the jaw once more falls flat; it shrinks according to the judgment of the eye, to half its size; the sockets are absorbed, and conveyed away; and in old age the coronoid process rises at a more acute angle from the jaw-bone, and by the falling down of the alveolar process, the coronoid process seems increased in length.

HOLE.—The holes of the jaw are chiefly two :

A **LARGE HOLE** on the inner side, and above the angle of the jaw, just at the point where these two branches, the condyloid and the coronoid processes part. A wide groove, from above downwards, leads to the hole ; and the hole is, as it were, defended by a small point, or pike of bone, rising up from its margin. This is the **GREAT HOLE** for admitting the **LOWER MAXILLARY NERVE** into the hollow of the jaw, where it goes round within the circle of the jaw, distributing its nerves to all the teeth. But at the point where this chief branch of the nerve goes down into the jaw, another branch of the nerve goes forward to the tongue. And as nerves make an impression as deep as that of arteries in a bone, we find here two grooves, first, one marking the great nerve, as it advances towards its hole ; and, secondly, a smaller groove, marking the course of the lesser branch, as it leaves the trunk, and passes this hole to go forward to the tongue.

Along with this nerve, the lower maxillary artery, a large branch enters also by the hole ; and both the nerve and the artery, after having gone round the canal of the jaw, emerge again upon the chin.

The second hole of the lower jaw is that on the side of the chin, which permits the remains of the great nerve and artery (almost expended upon the teeth) to come out upon the chin ; it is named the **MENTAL HOLE**.

CHAP. V.

OF THE BONES OF THE TRUNK ; OR, OF THE SPINE, THORAX, AND PELVIS.

THE spine is so named from certain projecting points of each bone, which, standing outwards in the back, form a continued ridge ; and the appearance of continuity is so complete, that the whole ridge is named spine, which, in common language, is spoken of as a single bone. This long line consists of twenty-four distinct bones, named *vertebræ*, from the Latin *vertere*, to turn. They conduct the spinal marrow, secure from harm the whole length of the spine, and support the whole weight of the trunk, head, and arms ; they perform, at certain points, the chief turnings and bendings of the body ;

and do not suffer under the longest fatigue, or the greatest weight which the limbs can bear. Hardly can any thing be more beautiful or surprising than this mechanism of the spine, where nature has established the most opposite and inconsistent functions in one set of bones ; for these bones are so free in motion, as to turn continually, yet so strong as to support the whole weight of the body ; and so flexible as to turn quickly in all directions, yet so steady within, as to contain and defend the most material and the most delicate part of the nervous system.

The vertebræ are arranged according to the neck, back, and loins, and the number of pieces corresponds with the length of these divisions. The vertebræ of the LOINS are five in number, very large and strong, and bearing the whole weight of the body. Their processes stand out very wide and free, not entangled with each other, and performing the chief motions of the trunk. The vertebræ of the BACK are twelve in number. They also are big and strong, yet smaller than those of the loins ; their processes are laid over each other ; each bone is locked in with the next, and embarrassed by its connection with the ribs ; this is, therefore, the steadiest part of the spine, a very limited motion only is allowed. The vertebræ of the NECK are seven in number ; they are more simple, and like rings ; their processes hardly project ; they are very loose and free ; and their motions are the widest and easiest of all the spine.

The seven vertebræ of the neck, twelve of the back, and five of the loins, make twenty-four in all, which is the regular proportion of the spine. But the number is sometimes changed, according to the proportions of the body ; for, where the loins are long, there are six vertebræ of the loins, and but eleven in the back ; or the number of the pieces in the back is sometimes increased to thirteen ; or the neck, according as it is long or short, sometimes has eight pieces, or sometimes only six.

The general form, processes, and parts of the vertebra, are best exemplified in the vertebra of the loins ; for in it the body is large, the processes are right-lined, large, and strong ; the joint is complete, and all its parts are very strongly marked. Every vertebra consists of a body, which is firm for supporting the weight of the body, and hollow behind, for transmitting the spinal marrow ; of two articulating processes above, and two below, by which it is jointed with the bones which are above and below it ; of two transverse processes which stand out from either side of the bone, to give hold and purchase to those muscles which turn the spine ; and of one pre-

cess, the spinous process, which stands directly backwards from the middle of the bone ; and these processes being felt in distinct points all the way down the back, give the whole the appearance of a ridge ; whence it has the name of spine.

The BODY of the VERTEBRA is a large mass of soft and spongy bone ; it is circular before, and flat upon the sides. It is hollowed into the form of a crescent behind, to give the shape of that tube in which the spinal marrow is contained. The body has but a very thin scaly covering for its thick and spongy substance. It is tipped with a harder and prominent ring above and below, as a sort of defence, and within the ring, the body of the vertebra is hollowed out into a sort of superficial cup, which receives the ligamentous substance by which the two next vertebræ are joined to it ; so that each vertebra goes upon a pivot, and resembles the ball and socket joints. And in many animals it is distinctly a joint of this kind.

On the fore and back part of the body of the vertebra are several holes which are for the transmission of blood-vessels and for the attachment of ligaments.

The BODY is the main part of the vertebra to which all the other processes are to be referred ; it is the centre of the spine, and bears chiefly the weight of the body ; it is large in the loins where the weight of the whole rests upon it, and where the movements are rather free : it is smaller in the vertebræ of the back, where there is almost no motion and less weight ; and in the vertebræ of the neck, there is hardly any body ; the vertebræ being joined to each other chiefly by the articulating processes.

The ring or circle of bone or the arch which, together with the body itself, forms this circle, next attracts our notice, for the arches of the vertebra, forming a continued tube, give passage to the spinal marrow. We observe a notch on each side of the arch for transmitting the nerves which go out from the spinal marrow.

The ARTICULATING PROCESS is a small projection, standing out obliquely from the body of the vertebra, with a smooth surface, by which it is joined to the articulating process of the next bone ; for each vertebra has a double articulation with that above and with that below. The bodies of the vertebræ are united to each other by a kind of ligament, which forms a more fixed, and rather an elastic joining ; and they are united again by the articulating processes, which makes a very moveable joint of the common form. The articulating processes are sometimes named oblique processes, because they stand rather obliquely. The upper ones are named the ascending

oblique processes, and the two lower ones are named the inferior or descending oblique processes.

The **SPINOUS PROCESSES** are those which project directly backwards, whose points form the ridge of the back, and whose sharpness gives the name to the whole column. The body of each vertebra sends out two arms, which, meeting behind, form an arch or canal for the spinal marrow; and from the middle of that arch, and opposite to the body, the spinous process projects. Now the spinous, and the transverse processes, are as so many handles and levers by which the spine is to be moved, which, by their bigness, give a firm hold to the muscles, and by their length, give them a powerful lever to work their effects by. The spinous processes, then, are for the insertion of these muscles which extend and raise the spine.

The **TRANSVERSE PROCESSES** stand out from the sides of the arms or branches which form this arch. They stand out at right angles, or transversely from the body of the bone; and they also are as levers, and long and powerful ones for moving and turning the spine. Perhaps their chief use is not for turning the vertebræ, for there is no provision for much of a lateral motion in the lower part of the spine, but the muscles which are implanted into these, are more commonly used in assisting those which extend and raise the spine.

These and all the processes, are more distinct, prominent, and strong; more direct and larger in the loins, and more easily understood than in the vertebræ of any other class. But this prepares only for the description of the individual vertebra, where we find a variety proportioned to the various offices and to the degrees of motion which each class has to perform.

OF THE VERTEBRÆ OF THE LOINS.—I have chosen to represent the general form of the vertebra, by describing one from the loins, because of the distinctness with which all its parts are marked. In the lumbar vertebræ, the perpendicular height of the body is short, the intervertebral substance is thicker in the other parts of the spine, and the several processes stand off from each other distinct and clear; all which are provisions for a freer motion in the loins. The arch of the lumbar vertebra is wider than in the back, to admit the looser texture of the spinal marrow.

The **BODY** of a lumbar vertebra is particularly large, thick, and spongy, and its thin outer plate is perforated by many arteries going inwards to nourish this spongy substance of the bone. The length of the body is about an inch, and the interstitial cartilage is nearly as long; so that the vertebræ of the loins present to the eye, looking from within the body, a

large, thick, and massy column, fit for supporting so great a weight.

The **SPINOUS PROCESS** is short, big, and strong. It runs horizontally and directly backwards from the arch of the spinal marrow. It is flattened, and about an inch in breadth; and it is commonly terminated by a lump or knob, indicating the great strength of the muscles which belong to it, and the secure hold which they have.

The **TRANSVERSE PROCESS** is also short, direct, and very strong, going off horizontally from the side of the bone, terminated like the spinous, by a knotty point, where large muscles are implanted. We find the spinous process divided into two unequal parts by a spine from the inferior articulating process; in the same manner we see the transverse process divided by a ridge extending from the superior articulating process.

The **ARTICULATING PROCESSES** of the lumbar vertebræ stand so directly upwards and downwards, that the name of oblique processes cannot be applied here.

Of the **VERTEBRÆ OF THE BACK**.—The character of the vertebræ of the back is directly opposite to that of the loins. The **BODIES** of the vertebræ are still large to support the great weight of the trunk; but they are much longer than in the loins, and their intervertebral substance is thin, for there is little motion here. The **SPINOUS PROCESSES** in the vertebræ of the back are very long and aquiline. They are broad at their basis, and very small or spinous at their further end; and in place of standing perpendicularly out from the body, they are so bent down, that they do not form a prominent nor unsightly spine, but are ranged almost in a perpendicular line, that is, laid over each other, like the scales of armour, the one above touching the one below, by which the motions of these vertebræ are still further abridged; and the further to sustain the column, there is a groove on the under surface of the spinous process, which receives the superior edge of the one below. And, lastly, the **TRANSVERSE PROCESSES**, which are short and knobby, in place of standing free and clear out like those of the loins, stand obliquely backward, are trampled and restricted from motion, by their connection with the ribs; for the ribs are not merely implanted upon the bodies of the dorsal vertebræ, but they are further attached firmly by ligaments, and by a regular joint to the transverse process of each vertebra. Now the rib being fixed to the body of one vertebra, and to the transverse process of the vertebra below, the motions of the vertebræ are much curbed. And we also get another mark by which the dorsal vertebræ may be known,

viz. that each vertebra bears two impressions of the rib which was joined to it, one on the flat side of its body, and the other on the fore part of its transverse process. The articulating processes are so short, that they can hardly be described as distinct projections, as they stand out so directly from the transverse process, appearing as parts of it.

We may distinguish the first vertebra of the back, by its having the whole of the head of the rib impressed upon its side.

The 12th, or lowest dorsal vertebra, has also the entire head of the rib impressed upon it, and it has no articulating surface on the extremity of the transverse process.

Of the VERTEBRÆ OF THE NECK.—The vertebræ of the neck depart still farther from the common form. Their BODIES are flattened on their fore parts, so as to make a flat surface on which the windpipe and gullet lie smooth. The BODY is very small in all the vertebræ of the neck. In the uppermost of the neck there is absolutely no body; and the next to that has not a body of the regular and common form. There is not in the vertebræ of the neck, as in those of the loins, a cup or hollow for receiving the intervertebral substance, but the surfaces of the body are flat or plain, and the articulating processes are oblique, and make as it were, one articulation with the body; for the lower surface of the body being not hollow, but plain, and inclined forwards, and the articulating processes being also inclined backwards, the two surfaces are plain, opposed to each other, and the one prevents the vertebræ from sliding forwards, and the other prevents it from sliding backwards, while a pretty free and general motion is allowed. The SPINOUS PROCESSES of the neck are short and project directly backwards; they are for the insertion of many muscles, and therefore they are split. This bifurcation of the spinous process is not absolutely peculiar to the cervical vertebræ; for sometimes, though rarely, the others are so: and it is only in the middle of the neck that even they are forked; for the first vertebra is a plain ring, with hardly any spinous process, because there are few muscles attached to it; and the process of the last vertebra of the neck is not bifurcated, so that it approaches to the nature of the dorsal vertebræ; the spinous process is long and aquiline; is depressed towards the back, and is so much longer than the others, as to be distinguished by the name of VERTEBRA PROMINENS.

The TRANSVERSE PROCESSES of the neck are also bifurcated, because there are a great many small muscles inserted into them also. But the most curious peculiarity of the transverse processes is that each of them is perforated for the

transmission of the great artery, which is named VERTEBRAL ARTERY, because it passes through these holes in the vertebræ, which form altogether a bony canal for the artery. This artery, which is defended with so much care, is one of the chief arteries of the brain, for there are two only; and often when the other, the carotid, has been obstructed, this continues to perform its office.

So that the character of these cervical vertebræ is, that they are calculated for much free motion; and the marks by which they are distinguished are, that the bodies are particularly small; the articulating processes oblique, with regard to their position, and almost plain on their surface. The spinous process, which is nearly wanting in the uppermost vertebræ, is short and forked in all the lower ones; the transverse process also is forked; and the transverse processes of all the vertebræ, except sometimes the first and last, are perforated near their extremities with the large hole of the vertebral artery.

ATLAS AND DENTATUS.—But among these vertebræ of the neck, two are to be particularly distinguished, as of greater importance than all the rest; for though the five lower vertebræ of the neck be ossified and fixed, if but the two uppermost remain free, the head, and even the neck, seem to move with perfect ease.

The first vertebra is named **ATLAS**, perhaps, because the globe of the head is immediately placed upon it; the second is named **DENTATA** or axis, because it has an axis or tooth-like process upon which the first turns.

The **ATLAS** has not the complete form of the other vertebræ of the neck, for its processes are scarcely distinguishable: it has no body, unless its own articulating processes are to be reckoned as a body: it is no more than a simple ring; it has hardly any spinous process; and its transverse process is long but not forked. On the upper margin of the ring may be observed the mark of the ligament which unites it to the margin of the occipital bone; and on the lower margin of the ring the mark of attachment of a similar ligament, which attaches it to the circle of the dentata. The **BODY** is entirely wanting; in its place, the vertebra has a flat surface looking backwards; which is smooth and polished by the rolling of the tooth-like process; there is also a sharp point rising perpendicularly upwards towards the occipital bone, and this point is held to the edge of the occipital hole by a strong ligament. The smooth mark of the tooth-like process is easily found; and upon either side of it, there projects a small point from the inner circle of the ring: these two points have a ligament

extended betwixt them, called the transverse ligament, which, like a bridge, divides the ring into two openings; one the smaller, for lodging the tooth-like process, embracing it closely; the greater opening is for the spinal marrow: the ligament confines the tooth-like process; and when the ligament is burst by violence (as has happened,) the tooth-like process, broken loose, presses upon the spinal marrow; the head, no longer supported by it, falls forward, and the patient dies. On the inside and lateral part of the circle, the origin of the lateral ligaments of the dentatus may also be observed.

The ARTICULATING PROCESS may be considered as the body of this vertebra; for it is at once the only thick part, and the only articulating surface. This broad articulating substance is in the middle of each side of the ring: it has two smooth surfaces on each side, one looking upwards, by which it is joined to the occiput; and one looking directly downwards, by which it is joined to the second vertebra of the neck. The two upper articulating surfaces are oval, and slightly hollow to receive the occipital condyles: they are also oblique, for the inner margin of each dips downwards; the outer margin rises upwards; and the fore end of each oval is turned a little towards its fellow. Now, by the obliquity of the condyles, and this obliquity of the sockets which receive them, all rotatory motion is prevented, and the head performs, by its articulations with the first vertebra or atlas, only the nodding motions; and when it rolls, it carries the first vertebra along with it, moving round the tooth-like process of the dentatus. The articulation with the head is a hinge joint, in the strictest sense: it allows of no other motion than that backwards and forwards; the nodding motions are performed by the head upon the atlas, the rotatory motions are performed by the atlas moving along with the head, turning upon the tooth-like process of the dentatus.

Now the upper articulating surface of the atlas is hollowed to secure the articulation with the head; but the lower articulation, that, with the dentatus, being secured already by the tooth-like process of that bone, no other property is required in the lower articulating surface of the atlas, than that it should glide with perfect ease; for which purpose, it is plain and smooth; it neither receives, nor is received into the dentatus by any hollow, but lies flat upon the surface of that bone. It is also evident, that since the office of the atlas is to turn along with the head, it could not be fixed to the dentatus, in the common way, by a body and by intervertebral substance; and since the atlas attached to the head moves along with it, turning as upon an axis, it must have no SPINOUS PROCESS;

for the projection of a spinous process must have prevented its turning upon the dentatus, and would even have hindered in some degree, the nodding of the head ; therefore the atlas has a simple ring behind, and has only a small knob or button where the spinous process should be, which, however, has a small notch on it. The TRANSVERSE PROCESS is not forked, but it is perforated with a large hole for the vertebral artery ; and the artery, to get into the skull, makes a wide turn, lying flat upon the bone, by which there is a slight hollow or impression of the artery, which makes the ring of the vertebra exceedingly thin.

But the form of the dentatus best explains these peculiarities of the atlas, and this turning of the head.

The DENTATA or AXIS is so named from its projecting point, which is the chief characteristic of this bone. When the dentata is placed upright before us, we observe, 1. That it is most remarkably conical, rising all the way upwards, by a gradual slope, to the point of its tooth-like process. 2. That the ring of the vertebra is very deep, that is, very thick in its substance, and that the opening of the ring for transmitting the spinal marrow is of a triangular form. 3. That its spinous process is short, thick, and forked ; and that it is turned much downwards, so as not to interfere, in any degree, with the rotation of the atlas. 4. That its tooth-like process, from which the bone is named, is very large, about half an inch in length ; very thick, like the little finger ; that it is pointed ; and that from this rough point a strong ligament goes upwards, by which the tooth is tied to the great hole of the occipital bone. We also observe a neck or collar, or smaller part, near the root of the tooth-like process, where it is grasped by the ring of the atlas ; while the point swells out a little above ; so that without the help of ligaments, it is almost locked in its place. We find this neck particularly smooth ; for it is indeed upon this collar that the head continually turns. And, we see on either side of this tooth-like process a broad and flat articulating surface, one on either side.—These articulating surfaces are placed like shoulders ; and the atlas being threaded by the tooth-like process of the dentatus, is set down upon the high shoulders of this bone, and there it turns and performs all the rotatory motions of the head.

On the side of the tooth-like process we may observe the insertion of the lateral ligaments, and its point is grasped by the perpendicular ligament.

We may observe, that the superior articulating process is

horizontal. The lower surface of this vertebra resembles the other inferior vertebra of the neck.

OF THE MEDULLARY TUBE, AND THE PASSAGE OF THE NERVES.—All the vertebræ conjoined make a large canal of a triangular or roundish form, in which the spinal marrow lies, giving off and distributing its nerves to the neck, arms, and legs; and the whole course of the canal is rendered safe for the marrow, and very smooth by lining membranes, the outermost of which is of a leather-like strength and thickness, and serves this double purpose; that it is at once a hollow ligament to the whole length of the spine upon which the bones are threaded, and by which each individual bone is tied and fixed to the next; and it is also a vagina or sheath which contains the spinal marrow, and which is bedewed on its internal surface with a thin exudation, keeping the sheath moist and soft, and making the enclosed marrow lie easy and safe.

All down the spine, this spinal medulla is giving off its nerves: One nerve passes from it at the interstice of each vertebra; so that there are twenty-four nerves of the spine, or rather forty-eight nerves; twenty-four being given towards each side; these nerves pass each through an opening or small hole in the general sheath; there they pass through the interstice of each vertebra; so that there is no hole in the bone required, but the nerve escapes by going under the articulating process. This, indeed, is converted into something like a hole, when the two contiguous vertebræ are joined to each other.

THE INTERVERTEBRAL SUBSTANCE.—The intervertebral substance is that which is interposed betwixt the bodies of two adjoining vertebræ, and which is (at last in the loins) nearly equal in thickness to the back of the body of the vertebra to which it belongs. We give it this undefined name, because there is nothing in the human system to which it is entirely similar; for it is not ligament, nor is it cartilage, but it is commonly defined to be something of an intermediate nature: It is a soft and pliant substance, which is curiously folded and returned upon itself, like a rolled bandage with folds, gradually softer towards the centre, and with the rolled edges as if cut obliquely into a sort of convex. The cut edges are thus turned towards the surface of the vertebra, to which each intervertebral substance belongs: it adheres to the face of each vertebra, and it is confined by a strong ligament all round: and this substance, though it still keeps its hold on each of the two vertebræ to which it belongs, though it permits no true motion of one bone on another, but only by twisting of its substance, yields, nevertheless, easily to which ever side we incline, and it

returns in a moment to its place by a very powerful resilience. This perfect elasticity is the chief character and virtue of this intervertebral substance, whose properties indeed are best explained by its uses; for, in the bendings of the body, it yields in a very considerable degree, and rises on the moment that the weight or the force of the muscles is removed. In leaping, in shocks, or in falls, its elasticity prevents any harm to the spine, while other less important joints are luxated and destroyed. During the day, it is continually yielding under pressure: so that we are an inch taller in the morning than at night: we are shorter in old age than in youth; and the aged spine, is bended forwards by the yielding of this part. These curious facts were first observed by a sort of chance, and have since been ascertained with particular care.

Since pressure, in length of years, shortens the forepart of the column of the spine, and makes the body stoop, any undue inclination to either side will cause distortion: the substance yields on one side, and rises on the other; and at last the same change happens in the bones also, and the distortion is fixed, and not to be changed: this is peculiarly apt to happen with children whose bones are growing, and whose gristles and intervertebral substances are peculiarly soft; so that a tumour on the head or jaw, which makes a boy carry his head on one side, or constant stooping, such as is used by a girl in working at the tambour, or the carrying of a weakly child always on one arm by a negligent or awkward nurse, will cause in time a fixed incurable distortion.

We are now qualified to understand the motions of the vertebræ, and to trace the degree of motion in each individual class. The degrees of motion vary with the forms of the vertebræ, in each part of the spine: the motion is freest in the neck, more limited in the loins, and in the back (the middle part of the spine) scarcely any motion is allowed: the head performs all the nodding motions upon the first vertebra of the neck: the first vertebra of the neck performs again all the quick and short turnings of the head, by moving upon the densatus: all the lower vertebræ of the neck are also tolerably free, and favour these motions by a degree of turning; and all the bendings of the neck are performed by them. The dorsal vertebræ are the most limited in their movements, bending chiefly forwards by the yielding of their intervertebral substance. The vertebræ of the loins again move largely, for their intervertebral substance is deep, and their processes quite unentangled and free. To perform these motions, each vertebra has two distinct joints, as different in office as in form: first, each vertebra is fixed to those above and below by the

intervertebral substance, which adheres so to each, that there is no true motion: there is no turning of any one vertebra upon the next; but the elasticity of the intervertebral substance allows the bones to move a little, so that there is a general twisting and gentle bending of the whole spine. The second joint is of the common nature with the other joints of the body, for the articulating processes are faced with cartilage, surrounded with a capsule, and lubricated with a mucus. And I conceive this to be the intention of the articulating processes being produced to such a length, that they may lap over each other to prevent luxations of the spine; and they must, of course, have these small joints, that they may yield to this general bending of the spine.

RIBS AND STERNUM.

OF THE RIBS.—The ribs, whose office it is to give form to the thorax, and to cover and defend the lungs, also assist in breathing; for they are joined to the vertebræ by regular hinges which allow of short motions, and to the sternum by cartilages, which yield to the motion of the ribs, and return again when the muscles cease to act.

Each rib, then, is characterised by these material parts; a great length of bone; at one end of which there is a head for articulation with the vertebræ, and a shoulder or knob for articulation with its transverse process; at the other end there is a point, with a socket for receiving its cartilage, and a cartilage joined to it, which is implanted into a similar socket in the side of the sternum, so as to complete the form of the chest.

The ribs are twelve in number, according to the number of the vertebræ in the back, of which seven are named true ribs, because their cartilages join directly with the sternum; and five are named false ribs, because their cartilages are not separately nor directly implanted into the sternum, but are joined one with another; the cartilage of the lower rib being joined and lost in that of the rib above, so that all the lower ribs run into one greater cartilage. But there is still another distinction, viz. that the last rib, and commonly also the rib above, are not at all implanted in the sternum, but are loosely connected only with the muscles of the abdomen, whence they are named the loose or floating ribs.

The ribs are, in general, of a flattened form, their flat sides being turned smooth towards the lungs. But this flatness of the rib is not regular, it is contorted, as if the soft rib had been seized by either end, and twisted betwixt the hands: the meaning of which is, to accommodate the flatness of the rib to the

form which the thorax assumes in all its degrees of elevation; for when the rib rises, and during its rising through all the degrees of elevation, it still keeps its flat side towards the lungs. Though of a flattened form, the rib is a little rounded at its upper edge, is sharp and cutting at its lower edge; and its lower edge seems double; for there is a groove made there by the intercostal artery and nerve. They are named intercostal, from lying betwixt the ribs, the artery being rather within the rib, is defended in some degree by its groove, the lip of which forms the lower edge of the rib, but still this artery is not without reach of the knife, in some surgical operations; we are careful, therefore, to mark, that it runs on the lower edge of the rib, and is of the size of a crow-quill; and that, if it be wounded, it will bleed largely from its nearness to the greatest artery of the body; that it is easily shunned, by keeping the knife nearer to the rib below.

On each rib we find the following parts: 1. The HEAD, or round knob by which it is joined to the spine. The head of each rib has indeed but a small articulating surface; but that smooth surface is double, or looks two ways. For the head of the rib is not implanted into the side of one vertebra, it is rather implanted into the interstice betwixt two vertebræ, the head touches both vertebræ; all the vertebræ except the first and last bear the mark of two ribs, one above, and one below. The mark of the rib is on the edge of either vertebræ, and the socket may be said to lie in the intervertebral substance betwixt them.

2. The NECK of the rib is a smaller part, immediately before the head. Here the rib is particularly small and round.

3. About an inch from the head, there is a second rising, or bump, the articulating surface by which it touches and turns upon the transverse process of the vertebra below. These two articulations have each a distinct capsule or bag, each is a very regular joint, and the degree of motions of the rib, and direction in which it moves, may be easily calculated, from the manner in which it is jointed with the spine; for the two articulating surfaces of the rib are on its back part; the back of the rib is simply laid upon the side of the spine; the joints with the body of the vertebræ, and with its transverse process, are in one line, and form as if but one joint, so that the rib being fixed obliquely, at one end only, that end continues firm, except in turning upon its axis; the two heads roll upon the body of the vertebræ, and upon the transverse process; and so its upper end continues fixed, while its lower end rises or falls; and as the motion is in a circle, the

head being the central point, moves but little, while the lower end of the rib has the widest range.

4. Just above the second articulating surface there is a second tubercle, which has nothing to do with the joints, but is intended merely for the attachment of the ligaments and muscles from the spine, which suspend and move the rib.

5. The angle of the rib is often mentioned, being a common mark for the place of surgical operations. There is a flatness of the thorax behind, forming the breadth of the back; the sharpness where this flatness begins to turn into the roundness of the chest is formed by the angles of the ribs. Each rib is round in the place of its head, neck and tubercles; it grows flatter a little, as it approaches the angle; but it is not completely flattened till it has turned the angle which is the proper boundary betwixt the round and the flat parts of the rib. This anatomy of the ribs is sufficiently simple, but it is not equally easy to observe how it bears on the practice of surgery. It is in some degree useful in the more advanced parts of anatomy, to remember the names, and it is necessary, even in speaking the common language of surgeons, to know these parts, viz. the head of the rib; the tubercle, or second articulating surface; the angle, or turning forward of the rib; the upper round, and the lower flat edge; and especially to remember the place and the dangers of the intercostal artery. It is, however, more important to consider the connections of parts, as the seat of the artery, the manner in which the ribs are lined with the pleura, and their nearness to the surface of the lungs. There are some peculiarities in individual ribs, the chief of which are these: the size or length of the ribs gradually decreases from the first to the last, the first being exceedingly short and circular, the lower ones longer, and almost right lined; so that the thorax is altogether of a conical shape, the upper opening so small as just to permit the trachea, œsophagus, and great vessels to pass; the lower opening so large, that equals the diameter of the abdomen: the first rib is consequently very short; it is thick, strong and of a flattened form; of which flatness one face looks upwards, and another downwards, and the great axillary artery and vein lie upon its flat upper surface. We do not see any groove on the lower surface for the intercostal artery. It is also particularly circular, making more than half a circle from its head to the extremity where it joins the sternum; it has, of course, no angle, and wants the distorted twisting of the other ribs: the second rib is also round, like the first rib. The eleventh and twelfth, or the floating ribs, are exceedingly small and delicate, and their cartilage terminates in an acute point, unconnected

with the sternum ; and lastly, the heads of the first, and of the twelfth ribs, are rounder than any of the others ; for these two have their heads implanted into the flat side of one vertebra only, while all the others have theirs implanted betwixt the bodies of two vertebræ. And there is this further difference, that in the eleventh and twelfth ribs there are no tubercles for the articulation with the transverse processes.

The cartilages of the ribs complete the form of the thorax, and form all the lunated edge of that cavity ; and it is from this cartilaginous circle that the great muscle of the diaphragm has its chief origin, forming the partition betwixt the thorax and the abdomen. The farther end of each rib swells out thick and spongy, and has a small socket for lodging the cartilage ; for these cartilages are not joined like the intervertebral substances with their bones : but there is a sort of joint very little moveable indeed, but still having a rude socket, and a strong capsular ligament, and capable of luxation by falls and blows ; the implantations into the sternum are evidently by fair round sockets, which are easily distinguished upon the two edges of that bone. These cartilages may be enumerated thus. The cartilages of the first and second ribs descend to touch the sternum. The cartilage of the third rib is direct. The cartilages of the fourth, fifth, and sixth ribs rise upwards, in proportion to their distance from this central one. The first five ribs have independent cartilages ; the eighth, ninth, and tenth ribs run their cartilages into the cartilage of the seventh rib ; and the eleventh and twelfth ribs have their cartilages small, unconnected, and floating loose.

By the motion of the ribs, the thorax is alternately dilated and diminished in capacity, the lungs thereby having their play. A rib has two motions. 1. Its sternal end rises and falls, the centre of motion being in the articulation with the spine. 2. It moves on its own axis ; a line drawn through the two extremities is the centre of this motion. The former motion enlarges and diminishes the diameter of the thorax, from the spine to the sternum, this enlarges the lateral diameter of the thorax.

THE STERNUM.—The sternum is that long and squared bone, which lies on the forepart of the breast over the heart, and which being joined by the cartilages of the ribs, completes the cavity of the chest ; it is for completing the thorax, and defending the heart, for a medium of attachment to the ribs, and for a fulcrum or point, on which the clavicles may roll.

This bone is light and spongy, and has a thin outer cortex, but depends in a great measure on the attachment of liga-

ments and tendons for its strength. From its structure it is liable to scrofulous disease.

We find the sternum consisting in the child of eight distinct pieces, which run together in the progress of life, and which in old age, are firmly united into one; but in all the middle stage of life, we find three pieces in the sternum, two of which are properly bone, the third remains a cartilage, till very late in life, and is named the ensiform cartilage, from its sword-like point.

It is found to have eight pieces, even in the child of six years old; some years after, it has but five or six; and the salient white lines which traverse the bone, mark where the intermediate cartilages have once been.

1. The upper piece of the sternum is very large, roundish or rather triangular, resembling the form of the heart on playing-cards: it is about two inches in length, and an inch and a half in breadth; and these marks are easily observed. The APEX, or point of the triangle, is pointed downwards to meet the second bone of the sternum. The BASE OF THE TRIANGLE, which is uppermost, towards the root of the throat seems a little hollowed, for the trachea passing behind it. On each upper corner, it has a large articulating hollow, into which the ends of the collar bones are received; (for this bone is the steady fulcrum upon which they roll.) A little lower than this, and upon its side is the socket for receiving the short cartilage of the first rib; and the second rib is implanted in the interstice betwixt the first and second bone of the sternum; so that one half of the socket for its cartilage is found in the lower part of this bone, and the other half in the upper end of the next.

2. The second piece of the sternum, is of a squared form, very long and flat, and composing the chief length of the sternum; for the first piece receives only the cartilage of the first rib, and one half of the second; but this long piece receives, on each side or edge of it, the cartilages of eight ribs: but as three of the lower cartilages are run into one, there are but five sockets or marks. The sockets for receiving the cartilages of the ribs, are on the edges of the sternum; they are very deep in the firm substance of the bone, and large enough to receive the point of the finger with ease: and whoever compares the size and deepness of these sockets, with the round heads of the cartilages which enter into them, will no more doubt of distinct joints here, than of the distinct articulation of the vertebræ with each other.

3. This is, in truth, the whole of the bony sternum; and what is reckoned the third piece, is a cartilage merely, and

continues so down to extreme old age. This cartilage which ckes out, and lengthens the sternum, and which is pointed like a sword, is thence named *CARTILAGO MUCRONATA*, the pointed cartilage, or *CARTILAGO ENSIFORMIS*, or *XIPHOIDES*, the sword-like cartilage. One half of the pit for the attachment of the seventh rib is on this portion. This cartilaginous point extending downwards over the belly, gives a sure origin and greater power to the muscles of the abdomen, and that without embarrassing the motions of the body; but this cartilage, which is commonly short and single pointed, is sometimes forked, sometimes bent inwards, so (it has been thought) as to occasion sickness and pain; and once was produced to such a length, as to reach the navel, and ossified at the same time, so as to hinder the bending of the body, and occasion much distress.

The sternum and the ribs, and all the chest stand so much exposed, that did we not naturally guard them with the hands, fractures must be very frequent, but indeed when they are broken, and beaten in, they hurt the heart or lungs, and not unfrequently the most dreadful consequences ensue. I have already explained that this class of bones, defending the most noble viscera (next to the brain,) the injuries are almost as fatal as injuries of the brain; often by a wheel passing over the body, the sternum is broken, its pieces press inwards upon the heart, which is sometimes burst; but more commonly the patients die a slow and miserable death; for the inflammation, which begins in the place of the wound is extended to the lungs, is propagated still onwards to the heart, and the heart being once inflamed, there comes anxiety, oppression, faintings and palpitations; anxious breathing, quick and interrupted pulse; still more frequent faintings, and then death. The ribs cover more properly the lungs, where the wound or inflammation is not always fatal; for the wound by the point of the rib, is no deeper than just to puncture the lungs; but through this small wound on their surface, the lungs breathe out their air into the cavity of the chest, and at last it escapes under the cellular substance of skin; the man is blown up to a prodigious degree with continually increasing anxiety, the breathing more and more interrupted, and were he not assisted, he would die.

PELVIS.

To give a steady bearing to the trunk, and to connect it with the lower extremities by a sure and firm joining, the pel-

vis is interposed, which is a circle of large and firm bones, standing as an arch betwixt the lower extremities and the trunk. Its arch is wide and strong, so as to give a firm bearing to the body; its individual bones are large, so as to give a deep and sure socket for the implantation of the thigh-bone; its motions are free and large, bearing the trunk above and rolling upon the thigh bones below; and it is so truly the centre of all the great motions of the body, that when we believe the motion to be in the higher parts of the spine, it is either the last vertebra of the loins bending upon the top of the pelvis, or the pelvis itself rolling upon the head of the thigh bones.

The PELVIS is named partly, perhaps, from its resembling a basin in its form; or perhaps, from its office of containing the urinary bladder, rectum, vagina, and womb; it consists in the child of many pieces, but in the adult it is formed of four large bones, of the os sacrum behind the ossa innominata on either side, and the os coccygis below.

OS SACRUM.—The names os sacrum, os basillare, &c. seem to relate rather to its greater size than to its ever having been offered in sacrifice. This bone, with its appendix the os coccygis, is called the false spine, or the column of the false vertebræ; authors making this distinction, that the true vertebræ are those of the back, neck, and loins, a column which grows gradually smaller upwards; the false vertebræ are those of the sacrum and coccyx, which are conical, with the apex or point downwards, and the base, viz. the top of the sacrum, turned upwards to meet the true spine.

The bones of which the sacrum is composed, had originally the form of distinct small vertebræ. These distinctions are lost in the adult, or are recollected only by the marks of former lines, for the original vertebræ are now united into one large and firm bone, which is named the column of false vertebræ; because, having no motion, it wants the chief character and use of the true ones.

We can recognize the original vertebræ, even in the adult bone, for we find it regularly perforated with holes, for the transmission of the spinal nerves; we find these holes regularly disposed in pairs; we see a distinct white and rising line which crosses the bone, in the interstice of each of the original vertebræ, and marks the place where the cartilage once was; and by these lines being five in number, with generally five pairs of holes, we know this bone to have consisted once of five pieces, which are now joined into one. The remains of former processes can also be distinguished, and the back of the bone is rough and irregular from the old spines.

The os sacrum, thus composed, is among the lightest bones of the human body, with the most spongy substance, the thinnest tables, the most easily broken, and its injuries of the most formidable nature; but then it is a bone the best cemented, and confirmed by strong ligaments, and the best covered by thick and cushion-like muscles. The os sacrum is of a triangular shape: the base of the triangle turned upwards to receive the spine; its inner surface is smooth, to permit the head of the child in labour to glide easily along, and its outer surface is irregular and rough, with the spines of former vertebræ, giving rise to the great glutæi muscles, (which form the contour of the hip,) and to all the strongest muscles of the back and loins.

It has in it a triangular cavity under the arch of its spinous processes; which cavity is continued from the canal in the vertebræ of the spine; and this cavity of the sacrum contains the continuation and the end of the spinal marrow, which being in this place divided into a great many thread-like nerves, has altogether the form of a horse's tail, and is therefore named *cauda equina*.

From this triangular cavity, the nerves of the *cauda equina* go out by the five great holes on the forepart of the sacrum, holes large enough to receive the point of the finger: the first three nerves of the sacrum, joining with the last two nerves of the loins, form the sacro-sciatic nerve, the largest in the body, which goes downward to the leg, while the two lower nerves of the sacrum supply the contents of the pelvis alone.

The back of the sacrum is also perforated with holes, whose size is nearly equal to those on its fore part, but whose uses are not so distinctly known; for the small nerve which pass outwards by them to the muscles of the loins or hips, are in no degree proportioned to the size of the holes.

All the edges of this triangle form articulating points, by which it is joined to other bones. The base, or upper part of the sacrum, receives the last vertebra of the loins on a large broad surface, which makes a very moveable joint; and indeed, the joining of the last true vertebra, with the top of the sacrum, is a point where there is more motion than in the higher parts of the spine. The sacrum has two articulating surfaces which stand perpendicular, and correspond with those of the lower lumbar vertebra. The apex, or point of the sacrum, has the os coccygis joined to it; which joining is moveable till the age of twenty in men, and till the age of forty-five in women; and the meaning of its continuing longer moveable in women, is very plain, since we distinctly feel the lower point of the coccyx in women yielding in the time of labour, so as to enlarge

greatly the lower opening of the pelvis. The sides of the os sacrum form a broad, rough, and deeply indented surface, which receives the like rough surface of the haunch bones; and here the surfaces are so rough, and the cartilage so thin, that it resembles more nearly a suture; and by the help of the strong ligaments, and of the large muscles which arise in common from either bone, makes a joining absolutely immovable, except by such violent force as is in the end fatal.

Thus the original state of this bone is easily recognised and traced by many marks; it stands in a conspicuous place of the pelvis, and its chief office is to support the trunk, to which we may add, that it defends the cauda equina, transmits its great nerves, forms chiefly the cavity of the pelvis; and that it is along the hollow of this bone that the accoucheur calculates the progress of the child's head in labour.

The *OS COCCYGIS*, so named from its resemblance to the beak of a cuckow, is a small appendage to the point of the sacrum, terminating this inverted column with an acute point, and found in very different conditions in the several stages of life. In the child it is merely cartilage, and we can find no point of bone; during youth it is ossifying into distinct bones, which continue moveable upon each other, till manhood: then the separate bones gradually unite with each other, so as to form one conical bone, which bulgings and marks of the pieces of which it was originally composed; but still the last bone continues to move upon the joint of the sacrum, till, in advanced years, it is at last firmly united, later in women than in men, with whom it is often fixed at twenty or twenty-five. The first bone is flat, with two transverse processes; the others become gradually of a roundish form, convex without, and concave inwards, forming, with the sacrum, the lowest part of the pelvis behind. It has no distinct holes, but the last sacral hole is frequently completed by a groove on the upper surface of the first bone; it has no communication with the spinal canal, but points forwards to support the lower part of the rectum; thus, it contracts the lower opening of the pelvis, so as to support effectually the rectum, bladder, and womb, and yet continues so moveable in women, as to recede in time of labour, allowing the head to pass.

The *OSSA INNOMINATA*—Are the two great irregular bones, forming the sides of the pelvis, which have a form so difficult to explain by one name, that they are called *ossa innominata*, the nameless bones. But these bones having been in the child formed in distinct and separate pieces, these pieces retain their original names, though united into one great bone: we continue to explain them as distinct bones, by the names

of os ilium, os ischium, and os pubis. The os ILIUM, the haunch-bone, is that broad and expanded bone on which lie the strong muscles of the thigh, and which forms the rounding of the haunch. The os ISCHIUM, the hip-bone, the lowest point of the pelvis, that on which we rest in sitting. The os PUBIS, or share-bone, on which the private parts are placed. All these bones are divided in the child; they are united in the very centre of the socket for the thigh-bone; and we find in the child a thick cartilage in the centre of the socket, and a prominent ridge of bone in the adult; which ridge, far from incommoding the articulation with the thigh-bone, gives a firmer hold to the cartilage which lines that cavity, and is the point into which a strong ligament from the head of the thigh-bone is implanted.

The os ILIUM, or haunch-bone, is named from its forming the flank. It is the largest part of the os innominatum. It rises upwards from the pelvis in a broad expanded wing, which forms the lower part of the cavity of the abdomen, and supports the chief weight of the impregnated womb (for the womb commonly inclines to one side.) The os ilium is covered with the great muscles that move the thighs, and to its edge are fixed those broad flat muscles which form the walls of the abdomen. This flat upper part is named the ALA, or WING, while the lower, or rounder part, is named the BODY of the bone, where it enters into the socket, and meets the other bones.

The ALA, or flat expanded wing, has many parts which must be well remembered, to understand the muscles which arise from them. 1. The whole circle of this wing is tipped with a ridge of firmer bone, which encircles the whole. This is a circular cartilage in the child, distinct from the bone, and is ossified and fixed only at riper years. All this ridgy circle is called the spine, and is the origin for several muscles. 2. The two ends of this spine are abrupt, and the points formed upon it are consequently named spinous processes, of which there are two at its fore and two at its back end. The two POSTERIOR SPINOUS PROCESSES are close by each other, and are merely two rough projecting points near the rough surface, by which the os ilium is joined to the os sacrum; they jut out behind the articulation, to make it firm and sure; and their chief uses seem to be the giving a firm hold to the strong ligaments which bind this joint. 3. The two anterior spinous processes are more distinct, and more important marks; for the ANTERIOR SUPERIOR SPINOUS PROCESS, is the abrupt ending of the spine, or circle of the ilium, with a swelling out; from which jutting point the sartorius muscle, the longest

and amongst the most beautiful in the human body, goes obliquely across the thigh, like a strap, down to the knee; another, which is called the *tenser vaginæ femoris*, also arises here; and from this point departs the ligament, which passing from the *os ilium* to the pubis, or fore point of the pelvis, is called the ligament of the thigh; how necessary it is to mark this point, may be easily deduced, from knowing that it is under the arch of this femoral ligament that the great artery passes down to the thigh, and that the femoral hernia is formed. The LOWER ANTERIOR spinous process is a small bump, or little swelling, about an inch under the first one, which gives rise to the *rectus femoris* muscle, or straight muscle of the thigh, which lies along its fore part, and upon the inside there is a depression lodging the *iliacus internus* and *psoas magnus*.

The back, or DORSUM of the *os ilium*, is covered with the three great *glutæi* muscles; we remark in a strong bone a semicircular ridge which runs from the upper part of the anterior or inferior spinous process, to the lower part of the bone (the notch.) The inner surface is hollowed, so as to be called the cup or hollow, or sometimes the venter.

This bone (the *os ilium*) has a broad rough surface, by which it is connected with the *os sacrum* at its side, the very form of which declares the nature of this joining, and is sufficient argument and proof that the joinings of the pelvis do not move.

The acute line, which is named *LINEA INNOMINATA*, is seen upon the internal surface of the bone, dividing the ala, or wing, from that part which is in the socket for the thigh. This line composes part of the brim of the pelvis, distinguishes the cavity of the pelvis from the cavity of the abdomen, and marks the circle into which the head of the child descends at the commencement of labour.

We find particularly on the dorsum many irregular ridges for the origin of muscles, and in many parts of the bone we see holes for transmitting vessels; we find one particularly large in the cup.

The *os ISCHIUM*, or hip-bone, is placed perpendicularly under the *os ilium*, and is the lowest point of the pelvis upon which we sit. It forms the largest share of the socket, whence the socket is named *acetabulum ischii*, as peculiarly belonging to this bone. The bump or round swelling upon which we rest is named the *tuber ischii*; and the smaller part, which extends upwards to meet the *os pubis*, is named the *ramus*, or branch, which meets a similar branch of that bone, to form the thyroid hole.

The **BODY** is the uppermost, and thicker part of the bone, which helps in forming the socket; and among the three bones this one forms the largest share of it; nearly one half. From the body, a sharp pointed process named **SPINOUS PROCESS** of the ischium, is projected backwards, which pointing towards the lower end of the sacrum, receives the uppermost of two long ligaments, which, from their passing betwixt the ischium and sacrum, are named **sacro-sciatic**; by this ligament a semi-circle of the **os ilium**, just below the joining of the ilium with the sacrum, is completed into a large round hole, which is in like manner named the **sacro-sciatic hole**, and gives passage to muscles, and to the great nerve of the lower extremity, named the **great sacro-sciatic nerve**.

The **TUBER**, or round knob, being the point upon which we rest, this bone has been often named **OS SEDENTARIUM**. The bump is a little flattened where we sit upon it. It is the mark by which the lithotomist directs his incision, cutting exactly in the middle betwixt the anus and this point of bone. It is remarkable as the point towards which the posterior or lower **sacro-sciatic ligament** extends, and as a point which gives rise to several of the strong muscles on the back of the thigh, and especially to those which form the **ham-strings**.

Between the scabrous surface on the tuber, and the edge of the **acetabulum**, there is a smooth surface rather depressed which is called the **CERVIX**. It is covered with a cartilage which allows the tendon of the **obturator** to move easily.

The **RAMUS**, or branch, rises obliquely upwards and forwards, to join a like branch of the **pubis**. This branch, or arm, as it is called, is flat, and its edges are turned a little forwards and backwards, so that one edge forms the arch of the **pubis**, while the other edge forms the margin of the **thyroid hole**.

The **OS PUBIS**, or **SHARE-BONE**, is the last and smallest piece of the **os innominatum**, and is named from the **mons veneris** being placed upon it, and its hair being a mark of puberty. It forms the upper, or fore part of the **pelvis**, and completes the brim, and, like the **ischium**, it also is divided into three parts, viz. the **BODY**, **ANGLE**, and **RAMUS**.

The **BODY** of the **os pubis** is thick and strong, and forms about one-fifth of the socket for the thigh bone. It is not only the smallest, but the shallowest part of the socket. The bone grows smaller, as it advances towards its angle, it again grows broad and flat, and the two bones meet with rough surfaces, but with two cartilages interposed. Over the middle of this bone, two great muscles, the **iliac** and **psoas** muscles, pass out of the **pelvis** to the thigh; and where they run under the

ligament of the thigh, they make the pubis very smooth. On the angle or crest there is a process which is frequently called tuberos angle : from this process there are two ridges traced ; one goes to meet the line on the ilium, and forms the linea ileo pectinea ; the other goes down towards the edge of the acetabulum ; between these two ridges there is a flat surface giving origin to the pectineus. The RAMUS, or branch, is that more slender part of the pubis, which, joining with the branch of the ischium, forms with it the arch of the pubis, and the edge of the thyroid hole. Just under the body of the bone, there is a groove which forms that part of the thyroid hole which transmits the obturator nerve and artery.

This completes the strict anatomy of the pelvis ; but when we consider the whole, it is further necessary to repeat, in short definitions, certain points which are oftener mentioned as marks of other parts.

The PROMONTORY of the sacrum is the projection formed by the lowest vertebra of the loins, and the upper point of that bone. The HOLLOW of the sacrum is all that smooth inner surface which gives out the great nerves for the legs and pelvis. The LESSER ANGLE, in distinction from the greater angle or promontory of the sacrum, is a short turn in the bone near where it is joined with the os coccygis. The CREST of the PUBIS is a sharper ridge or edge of the bone over the joining or symphysis pubis. The POSTERIOR SYMPHYSIS of the pelvis is the joining of the sacrum with the ilium, while the symphysis pubis is distinguished by the name of ANTERIOR SYMPHYSIS of the pelvis. The SPINE, the TUBER, and the RAMUS of the ischium are sufficiently explained. The ALA, or wing, the SPINE, the SPINOUS PROCESSES, and the LINEA INNOMINATA of the ilium, are also sufficiently explained. The ACETABULUM, so named from its resemblance to a measure which the ancients used for vinegar, is the hollow or socket for the thigh-bone, composed of the ilium, ischium, and pubis ; the ridge in its centre shows the place of its original cartilage, and points out what proportion belongs to each bone ; that it is made, two-fifths by the os ilium, two-fifths by the os ischium, and one-fifth only by the os pubis : but the ischium has the greatest share ; the ischium forming more than two-fifths, and the ilium less. The cavity, however, is not entirely completed by bone, for there is a ligament stretched across the inner and lower margin.

The BRIM of the PELVIS is that oval ring which parts the cavity of the pelvis from the cavity of the abdomen : it is formed by a continued and prominent line along the upper part of the sacrum, the middle of the ilium, and the upper part or crest of the pubis. This circle of the brim supports

the impregnated womb, keeps it up against the pressure of the labour pains ; and sometimes this line has been “ as sharp as “ a paper-folder, and has cut across the lower segment of the “ womb ;” and so, by separating the womb from the vagina, has rendered the delivery impossible ; and the child escaping into the abdomen among the intestines, the woman has died. The OUTLET of the PELVIS is the lower circle again, composed by the arch of the pubis, and by the sciatic ligaments, which is wide and dilatable, to permit the delivery of the child, but which being sometimes too wide, permits the child’s head to press so suddenly, and with such violence upon the soft parts, that the perineum is torn. The THYROID HOLE is that remarkable vacancy in the bone which perhaps lightens the pelvis, or perhaps allows the soft parts to escape from the pressure, during the passage of the head of the child.

The marks of the female skeleton have been sought for in the skull, as in the continuation of the sagittal suture ; but the truest marks are those which relate to that great function by which chiefly the sexes are distinguished : for while the male pelvis is large and strong, with a small cavity, narrow openings, and bones of greater strength, the female pelvis is very shallow and wide, with a large cavity, and slender bones, and with every peculiarity which may conduce to the easy passage of the child. And this occasions that peculiar form of the body which the painter is at greater pains to mark, and which is indeed very easily perceived ; for the characteristic of the manly form is firmness and strength ; the shoulders broad, the haunches small, the thighs in a direct line with the body, which gives a firm and graceful step. The female form again is delicate, soft, and bending ; the shoulders are narrow ; the haunches broad ; the thighs round and large ; the knees of course, approach each other ; and the step is unsure : the woman even of the most beautiful form, walks with a delicacy and feebleness, which we come to acknowledge as a beauty in the weaker sex.

The bones of the pelvis compose a cavity which cannot be fairly understood in separate pieces, but which should be explained as a whole. Though perhaps its chief office is supporting the spine, still its relation to labour deserves to be observed ; for this forms at least a curious inquiry, though it should not be allowed a higher place in the order of useful studies.

We know, from much experience, that where the pelvis is of the true size, we have an easy and natural labour : that where the pelvis is too large, there is pain and delay ; but not that kind of difficulty which endangers life : that where, by

distortion, the pelvis is reduced below the standard size, there comes such difficulty as endangers the mother, and destroys the child, and renders the art of midwifery still worthy of serious study, and an object of public care.

There was a time when it was universally believed, that the joinings of the pelvis dissolved in every labour; that the bones departed, and the openings were enlarged; that the child passed with greater ease; and "that this opening of the basin" was no less natural than the opening of the womb." By many accidents, this opinion has been often strengthened and revived; and if authority could determine our opinion, we should acknowledge, that the joinings of the pelvis were always dissolved as a wise provision of nature for facilitating natural, and preventing lingering labour, compensating for the frequent deviations both in the head and pelvis, from their true and natural size. This unlucky opinion has introduced, at one time, a practice the most reprehensibly simple, as fomentations to soften these joinings of the pelvis in circumstances which required very speedy help; while, at another time, it has been the apology for the most cruel, unnatural operations of instruments, not merely intended for dilating and opening the soft parts, but for bursting up these joinings of the bones. And those also, of late years, who have invented and performed (too often, no doubt,) this operation of cutting the symphysis pubis to hasten the labour, say, that they do not perform an unnecessary cruel operation, but merely imitate a common process of nature.

How very far nature is from intending this, may be easily known from the very forms of these joinings, but much more from the other offices which these bones have to perform; for if the pelvis be, as I have defined it, an arch standing betwixt the trunk and the lower extremities on which the body rolls, its joinings could not part without pain and lameness, perhaps inability for life.

One chief reason drawn from anatomy, is this: that in women dying after labour, the cartilages of the pelvis are manifestly softened; the bones loosen; and though they cannot be pulled asunder, they can be shuffled or moved upon each other in a slight degree: all which is easily accounted for. The cartilage that forms the symphysis pubis is not one cartilage only, as was once supposed, but a peculiar cartilage covers the end of each bone, and these are joined by a membranous or ligamentous substance: this ligamentous substance is the part which corrupts the soonest: it is often spoiled, and in the place of it a hollow only is found; that hollow of the corrupted ligament may be called a separation of the bones; but

it is such a separation "as equals only the back of a common knife in breadth, and will not allow the bones to depart from each other;" the joining is still strong, for it is surrounded by a capsular ligament, is not like the loose ligament of a moveable joint, but adhering to every point of each bone: and this ligament does perform its office so completely, that while it remains entire, though the bones shuffle sideways upon each other, no force can pull them asunder: "Even when the fore part of the pelvis is cut out, and turned and twisted betwixt the hands, still though the bones can be bent backwards and forwards, they cannot be pulled from each other the tenth part of an inch." These inquiries were made by one, who, though partial to the other side of this question, could not allow himself to disguise the truth, whose authority is the highest, and by whose facts I should most willingly abide.

Now, it is plain, that since a separation, amounting only to the 12th of an inch, occasions death, this cannot be a provision of nature; and since the separation in such degree could not enlarge the openings of the basin, there again it cannot be a provision of nature. I know that tales are not wanting of women whose bones were separated during labour; but what is there so absurd, that we shall not find a precedent or parallel case in our annals of monstrous and incredible facts? Or, rather, where is there a fact of this description which is not balanced and opposed by opposite authorities and facts? I have dissected several women who have died in lingering labour, where I found no disunion of the bones. I have seen women opened, after the greatest violence with instruments, and yet found no separation of the bones. We have cases of women having the mollities ossium, a universal softness, and bending of the bones, who have lived in this condition for many years, with the pelvis also affected; its openings gradually more and more abridged; the miserable woman suffering lingering labour, and undergoing the delivery by hooks, with all the violence that must be used in such desperate cases, and still no separation of the bones happening. How, indeed, should there be such difficult labours as these, if the separation of the bones could allow the child to pass?

If it be said, "the joinings of the pelvis are sometimes dissolved," I acknowledge that they are just as the joint of the thigh is dissolved, that is, sometimes by violence, and sometimes by internal disease; but if it be affirmed that "the joinings of the pelvis are dissolved to facilitate labour." I would observe, that wherever separation of the bones has happened, it has both increased the difficulties of the labour, and been in

itself a very terrible disease; for proofs of which, I must refer to Hunter, Denman, and others, to whose peculiar province such cases belong. But surely these principles will be universally acknowledged: that the pelvis supporting the trunk is the centre of its largest motions: that if the bones of the pelvis were loosened, such motions could no longer be performed: that when, by violence or by internal disease, or in the time of severe labour, these joinings have actually been dissolved or burst, the woman has become instantly lame, unable to sit, stand, or lie, or support herself in any degree; she is rendered incapable of turning, or even of being turned in bed; her attendants cannot even move her legs without intolerable anguish, as if torn asunder:* there sometimes follows a collection of matter within the joint, (the matter extending quite down to the tuber ischii), high fever, delirium, and death;† or, in case of recovery, (which is indeed more frequent), the recovery is slow and partial only; a degree of lameness remains, with pain, weakness, and languid health; they can stand on one leg more easily than on both, they can walk more easily than they can stand; but it is many months before they can walk without crutches; and long after they come to walk upon even ground, climbing a stair continues to be very difficult and painful. In order to obtain even this slow reunion of the bones, the pelvis must be bound up with a circular bandage very tight; and they must submit to be confined long: by neglect of which precautions, sometimes by the rubbing of the bones, a preternatural joint is formed, and they continue lame for years, or for life;‡ or sometimes the bones are united by ossification; the callus or new bone projects towards the centre of the pelvis, and makes it impossible for the woman to be delivered again of a living child.§

Now this history of the disease leads to reasons independent of anatomy, and surer than it; which prove, that this separation of the bones (an accident the existence of which cannot be questioned) is not a provision of nature, but is a most serious disease. For if these be the dreadful consequences of separation of the bones, how can we believe that it happens, when we see women walking during all their labour, and, in place of being pained, are rather relieved by a variety of postures, and by walking about their room? who often walk to bed after being delivered on chairs or couches? who rise on the third day, and often resume the care and fatigues of a family in a

* Denman.

† Hunter.

‡ Denman says twenty-five or thirty years.

§ Spence's cases.

few days more? or can we believe, that there is a tendency to separation of the bones in those who, following the camp, are delivered on one day and walk on the following? or in those women who, to conceal their shame, have not indulged in bed a single hour? or can we believe, that there is even the slightest tendency to the separation of the bones in those women whose pelvis resists the force of a lingering and severe labour, who suffer still further all the violence of instruments, who yet recover as from a natural delivery, and who also rise from bed on the third or fourth day?

CHAP. VI.

BONES OF THE THIGH, LEG, AND FOOT.

THE THIGH-BONE is the greatest bone of the body, and needs to be so, supporting alone, and in the most unfavourable direction, the whole weight of the trunk; for though the body of this bone is in a line with the trunk, in the axis of the body, its neck stands off almost at right angles with the body of the bone; and in this unfavourable direction must it carry the whole weight of the trunk, for the body is seldom so placed as to rest its weight equally upon either thigh-bone; commonly it is so inclined from side to side alternately, that the neck of one thigh bone bears alone the whole weight of the body and limbs, or is still loaded with greater burdens than the mere weight of the body itself.

The thigh-bone is one of the most regular of the cylindrical bones. Its BODY is very thick and strong, of a rounded form, swelling out at either end into two heads. In its middle it bends a little outwards, with its circle or convex side turned towards the forepart of the thigh. This bending of the thigh-bone has been a subject of speculation abundantly ridiculous, viz. whether this be an accidental or a natural arch. There are authors who have ascribed it to the nurse carrying the child by the thighs, and its soft bones bending under the weight. There is another author, very justly celebrated, who imputes it to the weight of the body, and the stronger action of the flexor muscles, assuming, that it is straight in the child, and grows convex by age. This could not be, else we should find this curve less in some, and greatest in those who had

walked most, or whose muscles had the greatest strength ; and if the muscles did produce this curve, a little accident giving the balance to the flexor muscles, should put the thigh-bone in their power to bend it in any degree, and to cause distortion. But the end of all such speculations is this, that we find it bended in the fœtus, nor yet delivered from the mother's womb, or in a chicken, while still enclosed in the shell ; it is a uniform and regular bending, designed and marked in the very first formation of the bone, and intended perhaps, for the advantage of the strong muscles in the back of the thigh, to give them greater power or more room.

The HEAD of the thigh-bone is likewise the most perfect of any in the human body, for its circumference is a very regular circle, of which the head contains nearly two-thirds : it is small, neat, and completely received into its socket, which is not only deep in itself and very secure, but is further deepened by the cartilage which borders it, so that this is naturally, and without the help of ligaments, the strongest joint in all the body ; but among other securities which are superadded, is the round ligament, the mark of which is easily seen, being a broad dimple in the centre of its head. In the surface of the head or ball we observe a small pit for the attachment of the round ligament of the hip-joint.

The NECK of this bone is the truest in the skeleton ; and indeed it is from this neck of the thigh-bone, that we transfer the name to other bones, which have hardly any other mark of neck than that which is made by their purse-like ligament being fixed behind the head of the bone, and leaving a roughness there. But the neck of the thigh-bone is more than an inch in length, thick, and strong, yet hardly proportioned to the great weights which it has to bear ; long, that it may allow the head to be set deeper in its socket ; and standing wide up from the shoulders of the bone, to keep its motions wide and free, and unembarrassed by the pelvis ; for without this great length of the neck, its motions had been checked even by the edges of its own socket.

The TROCHANTERS are the longest processes in the human body for the attachment of muscles, and they are named trochanter (or processes for turning the thigh,) from their office, which is the receiving those great muscles which not only bend and extend the thigh, but turn it upon its axis ; for these processes are oblique, so as to bend and turn the thigh at once.

The TROCHANTER MAJOR, the outermost and longer of the two, is that great bump which represents the direct end of the thigh-bone, while the neck stands off from it at one side ;

therefore the great trochanter stands above the neck, and is easily distinguished outwardly, being that great bump which we feel so plainly in laying the hand upon the haunch. On the upper and forepart of this great process, are two surfaces for the insertion of the gluteus medius and minimus.

The extremity of the great trochanter hangs over a pit into which principally the small rotator muscles of the thigh are inserted, viz. the pyriformis, the genini, the obturator internus and externus. On the lower part there is a very strong marked ridge, which is for the insertion of the gluteus maximus.

The TROCHANTER MINOR, or lesser trochanter, is a smaller and more pointed rising on the inner side of the bone, lower than the trochanter major, and placed under the root of the neck, as the greater one is placed above it. It is deeper in the thigh, and never to be felt, not even in luxations. Its muscles also, viz. the flexors of the thigh, by the obliquity of their insertion into it, turn the thigh, and bend it towards the body, such as the psoas and iliacus internus, which passing out from the pelvis, sink deep into the groin, and are implanted into this point. From the one trochanter to the other, there is a very conspicuous roughness, which marks the place of the capsule or ligamentary bag of the joint; for it encloses the whole length of the neck and of the thigh-bone. This roughness begins the great rough line, and is what is regularly named *linea aspera*.

Between the greater and lesser trochanters, there runs a rough line, the *inter trochantral line*, to which the capsular ligament is attached, and into which the quadratus femoris is inserted.

The LINEA ASPERA is a rising or prominent line, very ragged and unequal, which runs all down the back part of the thigh: it begins at the roots of the two trochanters, and the rough lines from each trochanter meet about four inches down the bone; thence the linea aspera runs down the back of the bone a single line, and forks again into two lines, one going towards each condyle, and ending in the tubercles at the lower end of the bone, so that the linea aspera is single in the middle, and forked at either end.

The CONDYLES are the two tubers into which the thigh-bone swells out at its lower part. There is first a gentle and gradual swelling of the bone, then an enlargement into two broad and flat surfaces, which are to unite with the next bone in forming the great joint of the knee. The two tuberosities, which, by their flat faces, form the joint, swell out above the joint, and are called the CONDYLES. The INNER CONDYLE is larger, to compensate for the oblique position of the thigh-

bone ; for the bones are separated at their heads, by the whole width of the pelvis, but are drawn towards a point below, so as to touch each other at the knees. On the forepart of the bone, betwixt the condyles, there is a broad smooth surface, upon which the rotula, or pulley-like bone glides. The outer side of this trochlea is the largest and most prominent. On the back part of the thigh-bone, in the middle, betwixt the condyle, there is a deep notch, which gives passage to the great artery, vein, and nerve of the leg.

The great nutritious artery enters below the middle of this bone, and smaller arteries enter through its porous extremities ; as may be known by many small holes, near the head of the bone.

The HEAD of the thigh-bone is round, and set down deeply in its socket, to give greater security to a joint so important, and so much exposed as the hip is. The NECK stands off from the rest of the bone, so that by its length it allows a free play to the joint, but is itself much exposed by its transverse position, as if nature had not formed in the human body any joint at once free, moving, and strong. The neck is not formed in the boy, because the socket is not yet deep, nor hinders the motions of the thigh, and the head is formed apart from the bone, and is not firmly united with it till adult years, so that falls luxate or separate the head in young people, but they break the neck of the bone, in those that are advanced in years. The TROCHANTERS, or shoulders, are large, to receive the great muscles which are implanted in them, and oblique, that they may at once bend and turn the thigh. The SHAFT or BODY is very strong, that it may bear our whole weight, and the action of such powerful muscles ; and it is marked with the rough line behind, from which a mass of flesh takes its rise, which warps completely round the lower part of the thigh-bone, and forms what are called the vasti muscles, the greatest muscles for extending the leg. The CONDYLES swell out to give a broad surface, and a firm joining for the knee. But of all its parts, the great trochanter should be most particularly observed, as it is the chief mark in luxations or fractures of this bone : for when the greater trochanter is pushed downwards, we find the thigh luxated inward ; when the trochanter is higher than its true place, and so fixed that it cannot roll, we are assured that it is luxated ; but when the trochanter is upwards, with the thigh rolling freely, we are assured its neck is broken, the trochanter being displaced, and the broken head remaining in its socket ; but when the trochanter remains in its place, we should conclude that the joint is but little injured, or that it is only a bruise of those glands

or mucous follicles, which are lodged within the socket, for lubricating the joint.

The TIBIA is named from its resemblance to a pipe ; the upper part of the tibia, representing the expanding or trumpet-like end, the lower part representing the flute end of the pipe. The tibia, on its upper end, is flat and broad, making a most singular articulation with the thigh-bone ; for it is not a ball and socket like the shoulder or hip, nor a hinge-joint guarded on either side with projecting points, like the ankle. There is no security for the knee-joint, by the form of its bones, for they have plain flat heads ; they are broad indeed, but they are merely laid upon each other. It is only by its ligaments that this joint is strong ; and by the number of its ligaments it is a complex and delicate joint, peculiarly liable to disease.

The UPPER HEAD of the tibia, is thick and spongy, and we find there two broad and superficial hollows, as if impressed, while soft, with the marks of the condyles of the thigh-bone ; and these slight hollows are all the cavity that it has for receiving the thigh-bone. A pretty high ridge rises betwixt these two hollows, so as to be received into the interstice betwixt the condyles, on the back part, which is the highest point of the ridge. There is a pit on the fore and on the back part for the attachment of the crucial ligaments. The spongy head has also a rough margin, to which the capsular ligament is tied. On the fore part of this bone, just below the knee, there is a bump for receiving the great ligament of the patella, or, in other words, the great tendon of all the extensor muscles of the leg ; and lastly, there is upon the outer side of this spongy head, just under the margin of the joint, a smooth articulating surface, (like a dimple impressed with the finger,) for receiving the head of the fibula. It is under the margin of the joint, for the fibula does not enter at all into the knee joint ; it is only laid upon the side of the tibia, fixed to it by ligaments, but not received into any thing like a cavity.

The BODY of the bone is of a prismatic or triangular form, and its three edges or acute angles are very high lines running along its whole length. The whole bone is a little twisted to give a proper position to the foot. One line, the anterior angle, a little waved, and turned directly forwards, is what is called the shin. At the top of this ridge, is that bump into which the ligament of the rotula or patella is implanted ; and the whole length of this acute line is so easily traced through the skin, that we can never be mistaken about fractures of this bone. Another line less acute than this, is turned directly backwards ; and the third acute line, which completes the triangular form, is turned towards the fibula, to receive a broad

ligament, or interosseous membrane, which ties the two bones together.

The lower extremity of the tibia has a deep pit or cavity of articulation, which is called the scaphoid cavity; it receives the astragalus.

The middle of the posterior surface of the bone is hollowed for the lodgment of the muscles, which extend the foot, and bend the toes; and the anterior and outer surface is hollowed by the lodgment of that muscle, which is called tibialis anticus, and the long extensors of the toes.

On the back part of the bone, near its head, there is a flat surface made by the insertion of the popliteous muscle, which is bounded on the lower part by a ridge giving origin to one of the flexors.

The lower head of the tibia composes the chief parts of the ankle-joint. The lower head of the tibia is smaller than the upper, in the same proportion, that the ankle is smaller than the knee. The pointed part of this head of the tibia represents the mouth-piece, or flat part of the pipe, and constitutes the bump of the INNER ANKLE. The lower end of the fibula lies so upon the lower end of the tibia, as to form the outer ankle; and there is on the one side of the tibia a deep hollow, like an impression made with the point of the thumb, which receives the lower end of the fibula. The acute point of the tibia, named the process of the inner ankle, passes beyond the bone of the foot, and, by lying upon the side of the joint, guards the ankle, so that it cannot be luxated outward, without this pointed process of the maleolus internus, or inner ankle, being broken.

On the back of the lower head of the bone there is a groove which transmits the tendon of the tibialis posticus muscle, and at its apex a pit giving origin to the deltoid ligament.

On the back part of the tibia, and a little below its head, we have to observe the hole for the transmission of the nutritious artery, to the centre of the bone. In amputation of the leg, this artery is sometimes cut across just where it has entered the bone, and the bleeding proves troublesome.

The tibia is a bone of great size, and needs to be so, for it supports the whole weight of the body. It is not at all assisted by the fibula, in bearing the weight, the fibula, or slender bone, being merely laid upon the side of the tibia, for uses which shall be explained presently. The tibia is thick, with much cancelli, or spongy substance within; has pretty firm plates without; is much strengthened by its ridges, and by its triangular form: its ridges are regular with regard to each other, but the whole bone is twisted as if it had been turned

betwixt the hands when soft: this distortion makes the process of the inner ankle lie not regularly upon the side of that joint, but a little obliquely forward, determining the obliquity of the foot, which must be of much consequence, since there are many provisions for securing this turning of the foot, viz. the oblique position of the trochanters; the oblique insertion of all the muscles, and this obliquity of the ankles; the inner ankle advancing a little before the joint, and the outer ankle receding in the same degree behind it.

The FIBULA, which is named so from its resemblance to the Roman clasp, is a long slender bone, which is useful partly in strengthening the leg, but chiefly in forming the ankle-joint; for the tibia only is connected with the knee, while the fibula, which has no place in the knee-joint, goes down below the lower end of the tibia, forming the long process of the outer ankle.

The fibula is a long and slender bone, the longest and slenderest in the body. It lies by the side of the tibia like a splint, so that when at any time the tibia is broken without the fibula, or when the tibia having spoiled, becomes carious, and a piece of it is lost, the fibula maintains the form of the limb till the last piece be replaced, or till the fracture be firmly re-united. It is like the tibia, triangular in the middle part, but square towards the lower end, and has two heads, which are knots, very large, and disproportioned to so slender a bone. The sharpest line of the fibula is turned to one sharp line of the tibia, and the interosseous membrane passes betwixt them. The other lines or spines are the interstices of the attachment of muscle, which, arising from this bone, are called peronei. The bone lies in a line with the tibia, on the outer side of it, and a little behind it. The upper head of the fibula is rough on the outer surface, for the insertion of the lateral ligament, and of the *biceps cruris*, smooth and light, with cartilage within, and is laid upon a plain smooth surface, on the side of the tibia, a little below the knee; and though the fibula is not received deep into the tibia, this want is compensated for by the strong ligaments by which this little joint is tied by the knee, being completely wrapped round with the expanded tendons of those great muscles which make up the thigh, by the knee being still farther embraced closely by the fascia, or tendinous expansion of the thigh; but above all, by the tendons of the outer ham-strings being fixed into this knot of the fibula, and expanding from that over the forepart of the tibia.

The lower head of the fibula is broad and flat, and is let pretty deep into the socket on the side of the tibia; together, they form the ankle-joint for receiving the bones of the foot.

The extreme point of the thin extremity gives attachment to the outer ligament of the joint, and is sometimes called the coronoid process. On the back part of this lower head, there is a furrow which lodges the tendons of the peronei muscles. The ankle-joint is one of the purest hinge joints, and is very secure ; for there is the tibia at the process of the inner ankle, guarding the joint within ; there is the fibula passing the joint still further, and making the outer ankle still a stronger guard without. These two points, projecting so as to enclose the bones of the foot making a pure hinge, prevent all lateral motion ; make the joint firm and strong, and will not allow of luxations, till one or both ankles be broken. We know that there is a little motion betwixt the tibia and fibula ; none that is sensibly outwardly, and no more in truth than just to give a sort of elasticity, yielding to slighter strains. But we are well assured, that this motion, though slightest and imperceptible, is very constant ; for these jointings of the fibula with the tibia are always found smooth and lubricated ; and there are no two bones in the body so closely connected as the tibia and fibula are, which are so seldom anchylosed, (*i. e.*) joined into one by disease.

The fibula may be thus defined : it is a long slender bone, which answers to the double bone of the fore-arm, completes the form, and adds somewhat to the strength of the leg ; it gives a broader origin for its strong muscles, lies by the side of the tibia like a splint ; and, being a little arched towards the tibia, supports it against those accidents which would break it across, and maintains the form of the leg when the tibia is carious or broken ; the fibula, though it has little connexion with the knee, passes beyond the ankle-joint, and is its chief guard and strength in that direction in which the joint should be most apt to yield ; and in this office of guarding the ankle, it is so true, that the ankle cannot yield till this guard of the fibula be broken.

ROTULA OR PATELLA, OR KNEE-PAN, is a small thick bone, of an oval, or rather triangular form. The basis of this rounded triangle is turned upwards to receive the four great muscles which extend the leg : the pointed part of this triangle is turned downwards and is tied by a very strong ligament to the bump or tubercle of the tibia, just under the knee. The convex surface is rough, the concave smooth, and divided by a ridge into two equal parts ; round the margin of the bone there is a slight depression for the attachment of the capsular ligament. This ligament is called the ligament of the patella, or of the tibia, connecting the patella so closely, that some anatomists of the first name, choose to speak of the patella as a mere

process of the tibia, (as the olecranon is a process of the ulna,) only flexible and loose; an arrangement which I think so far right and useful, as the fractures of the olecranon and of the patella are so much alike, especially in the method of cure, that they may be spoken of as one case; for these two are the only exceptions to the common rules and methods of setting broken bones.

The patella is manifestly useful, chiefly as a lever; for it is a pulley, which is a species of lever, gliding upon the forepart of the thigh-bone, upon the smooth surface which is betwixt the condyles. The projection of this bone upon the knee removes the acting force from the centre of motion, so as to increase the power; and it is beautifully contrived, that while the knee is bent, and the muscles at rest, as in sitting, the patella sinks down, concealed into the hollow of the knee. When the muscles begin to act, the patella begins to rise from this hollow; in proportion as they contract they lose their strength, but the patella, gradually rising, increases the power; and when the contraction is nearly perfect, the patella has risen to the summit of the knee, so that the rising of the patella raises the mechanical power of the joint in exact proportion as the contraction expends the living contractile power of the muscles. What is curious beyond almost any other fact concerning the fractures of bones, the patella is seldom broken by a fall or blow; in nine of ten cases, it is rather torn, if we may use the expression, by the force of its own muscles, while it stands upon the top of the knee, so as to rest upon one single point; for while the knee is half bended, and the patella in this dangerous situation, the leg fixed, and the muscles contracting strongly to support the weight of the body, or to raise it as in mounting the steps of a stair, the force of the muscles is equivalent at least to the weight of a man's body; and often, by a sudden violent exertion, their power is so much increased, that they snap the patella across, as we would break a stick across the knee.

The TARSUS OR INSTEP, is composed of seven large bones, which form a firm and elastic arch for supporting the body; which arch has its strength from the strong ligaments with which these bones are joined, and its elasticity from the small movements of these bones with each other; for each bone and each joint has its cartilage, its capsule or bag, its lubricating fluid, and all the apparatus of a regular joint; each moves since the cartilages are always lubricated, and the bones are never joined by ankylosis with each other; but the effect is rather a diffused elasticity than a marked and perceptible motion in any one joint.

The seven bones of which the tarsus is composed are, 1. The ASTRAGALUS, which united with the tibia and fibula, forms the ankle-joint. 2. The os CALCIS, or heel-bone, which forms the end or back point of that arch upon which the body stands. 3. The os NAVICULARE, or boat-like bone, which joins three smaller bones of the forepart of the tarsus to the astragalus. 4. The os CUBOIDES, which joins the smaller bones of the forepart of the os calcis. The 5th, 6th, and 7th, are the smaller bones making the forepart of the tarsus; they lie immediately under the place of the shoe-buckle, and are named the three CUNEIFORM BONES, from their wedge-like shape; and it is upon these that the metatarsal bones, forming the next division of the foot, are implanted.

These bones of the tarsus form, along with the next rank, or metatarsal bones, a double arch; first from the lowest point of the heel to the ball of the great toe, is one arch; the arch of the sole of the foot which supports the body; and again, there is another arch within this, formed among the tarsal bones themselves, one within another, (*i. e.*) betwixt the astragalus, os calcis, and naviculare, through which hole in my drawing there is passed a pencil. It is this second arch which gives a perfect elasticity to the foot, and must prevent the bad effects of leaping, falls, and other shocks, which would have broken a part less curiously adapted to its office.

1. The ASTRAGALUS is the greatest and most remarkable bone of the tarsus, and which the surgeon is most concerned in knowing. The semi-circular head of this bone forms a curious and perfect pulley. The circle of this pulley is large: its cartilage is smooth and lubricated; it is received deep betwixt the tibia and fibula, and rolls under the smooth articular surface of the latter, which being suited to this pulley of the astragalus, with something of a boat-like shape, is often named the scaphoid cavity of the tibia. 1. We remark in the astragalus its articulating surface, which is arched, high, smooth, covered with cartilage, lubricated, and in all respects a complete joint. Its form is that of a pulley, which, of course admits of but one direct motion, viz. forwards and backwards. 2. We observe its sides, which are plain, smooth and flat, covered with the same cartilage, forming a part of the joint, and closely locked in by the inner and outer ankles, so as to prevent luxations, or awkward motions to either side. 3. We observe two large irregular articulating surfaces backwards, and downwards, by which it is joined to the os calcis. 4.—There is on the forepart, or rather the fore end of the astragalus, a large round head, as regular as the head of the

shoulder-bone by which it is articulated with the scaphoid bone.

POINTS OF DEMONSTRATION.

1. Superior surface corresponding with the scaphoid cavity of the tibia. 2. Internal articulating surface for the maleolus internus. 3. External articulating surface for the extremity of the fibula. 4. Inferior articulating surface joining with the body of the os calcis. 5. Inferior and lateral surface articulating also with a corresponding surface of the os calcis. 6. Deep fossa dividing these two inferior articulating surfaces. 7. The ball or anterior articulating surface which enters into the socket of the naviculare. 8. A smooth part which is like a continuation of this last, but which rests upon a cord or tendon which is stretched betwixt the os calcis and naviculare. 9. Furrow for attachment of the capsular ligament.

2. The OS CALCIS is the large irregular bone of the heel; it is the tip or end of the arch formed by the tarsal or metatarsal bones. There is an irregular surface on the highest part of the projection backwards to which the tendo achilles is inserted. The lower and back part of the bone is rough but peculiar in its texture for the attachment of the cartilaginous and cellular substance on which it rests. We next notice an irregular articular surface, or rather two surfaces covered with cartilage, by which this bone is joined with the astragalus. Another articulating surface by which it is joined with the os cuboides. A sort of arch downwards, under which the vessels and nerves and the tendons also pass on safely into the sole of the foot, and on this part a depression for the peroneus longus.

On the upper surface of the bone, and betwixt the surfaces which articulate with the astragalus, there is an irregular rough fossa, which is opposite to a corresponding depression in the astragalus, and which gives attachment to powerful ligaments which unite the bones, and, on the lower and outer part, the sinuosity.

We further notice the tubercle which stands internally, and gives attachment to the ligamentum inter os calcem naviculare et astragalum.

3. The next bone is named OS NAVICULARE, or OS SCAPHOIDES, from a fanciful resemblance to a boat. But this is a name of which anatomists have been peculiarly fond and which, they have used with very little discretion or reserve: the student will hardly find any such resemblance. That concave side which looks backwards, is pretty deep, and receives the head of the astragalus: that flat side which looks forwards

has not so deep a socket, but receives the three cuneiform bones upon a surface rather plain and irregular. From the inner and lower part of this bone a tubercle stands out for the attachment of a powerful ligament, already described.

The CUNEIFORM BONES are so named, because they resemble wedges, being laid to each other like the stones of an arch. The most simple and proper arrangement is, 1. 2. and 3. ; counting from the side of the great toe towards the middle of the foot; but they are commonly named thus : the first cuneiform bone, on which the great toe stands has its cutting edge turned upwards ; it is much larger than the others, and so is called *OS CUNEIFORM MAGNUM*. The second cuneiform bone, or that which stands in the middle of the three cuneiform bones, is much smaller, and is therefore named *OS CUNEIFORM MINIMUM*. The third in order, of the cuneiform bones, is named *OS CUNEIFORM MEDIUM*.* These cuneiform bones receive the great toe and the two next to it. The fourth and fifth toes are implanted upon the last bone in the row, the *os cuboides*.

OS CUBOIDES.—The *os cuboides* is named from its cubical figure, and is next to the astragalus in size, greater than the scaphoid bone. The three cuneiform bones are laid regularly by the side of each other ; and this *os cuboides* is again laid on the outer side of the third cuneiform bone and joins it to the *os calcis*. Its anterior point is divided into two surfaces for two metatarsal bones. The place and effect of the cuboid bone is very curious ; for, as it is jammed in betwixt the third cuneiform bone and the *os calcis*, it forms a complete arch within an arch, which gives at once a degree of elasticity and of strength which no human contrivance could have equalled. There is first a great arch on which the body rests, and the heel and the great toe are the horns of that bow : and, secondly, there is a complete circle among the metatarsal bones, leaving an opening betwixt the astragalus and the *os calcis*. The *os cuboides* has several irregular depressions on its lower surface, but one particularly marked for the *peroneus longus*.

THE TOES.—The last division of the foot consists of three distinct bones ; and as these bones are disposed in rows, they are named the first, second and third phalanges or ranks of the toes.

* The confusion in these names arises from sometimes counting them by their place, and sometimes reckoning according to their size. It is only in relation to its size that we call one of these bones *os cuneiform medium* ; for the *os cuneiform medium* is not in the middle of the three ; it is the middle bone with respect to size : it is the smallest of the cuneiform bones that stand in the middle betwixt the other two.

The great toe has but two phalanges ; the other toes have three ranks of bones, which have nothing particular, only the joints are round and free, formed by a round head on one bone, and by a pretty deep hollow for receiving it in the one above it ; they are a little flattened on their lower side, or rather they have a flattened groove which lodges the tendons of the last joint of the toes.

THE SESAMOID BONES are more regularly found about the toes than any where else. They are small bones, like peas, found in tendons, at any point where they suffer much friction ; or rather they are like the seeds of the sesamum, whence their name. They are found chiefly at the roots of the great toe, and of the thumb ; at each of these places we find two small sesamoid bones, one on each side of the ball of the great toe, and one on each side of the ball of the thumb ; but these bones do not enter into the joint ; they are within the substance of the tendons ; perhaps, like the patella, they remove the acting force from the centre of motion, and so by acting like pulleys, they increase the power ; perhaps also by lying at the sides of the joint in the tendons of the shorter muscles of the toes, they make a safe gutter for the long tendons to pass in. They are not restricted to the balls of the great toe and thumb, but sometimes are also found under the other toes and fingers and sometimes behind the condyles of the knee ; or in the peronæi tendons, which run under the sole of the foot. In short, they are so far from being regular bones, that they are found only in adults, and are so often found in irregular places, that they almost seem to be produced by chance, or by the effect of friction.

METATARSUS.—The metatarsus, so named from its being placed upon the tarsus, consists of five bones, which differ very little from the first bones of the fingers. The metatarsal bones are five in number ; they are rather flattened, especially on their lower sides, where the tendons of the toes lie ; they have a ridge on their upper or arched surface ; they are very large at their ends next the tarsus, where they have broad flat heads, that they may be implanted with great security ; they grow smaller towards the toes, where again they terminate, in neat small round heads, which receive the first bones of the toes, and permit of a very free and easy motion, and a greater degree of rotation than our dress allows us to avail ourselves of, the toes being cramped together, in a degree that fixes them all in their places, huddles one above another, and is quite the reverse of that free and strong-like spreading of the toes, which the painter always represents. It should be remarked, that the nearer extremity of the metatarsal bone of

the little toe makes a salient angle projecting over the tarsus, in a point which is easily felt outwardly, on the side of the foot. This and all other marks of the metatarsal bones are chiefly useful as directing us where to cut in amputating these bones; and the surgeon will save the patient much pain, and himself the shame of a slow and confused operation, by marking the places of the joints. The metatarsal bone of the great toe is the strongest and shortest. The articulating surface of its nearer extremity is larger and deeper; and its anterior articulating surface is marked by a ridge which corresponds with the interstice of the sesamoid bones.

CHAP. VII.

BONES OF THE SHOULDER, ARM, AND HAND.

OF THE SCAPULA, OR SHOULDER-BLADE.

THIS is the great peculiarity of the superior extremity, that it is connected not directly with the trunk, like the thigh-bone with the haunch, but is hung by a moveable intermediate bone, which not only is not immediately joined to the trunk by ligaments, nor any other form of connexion, but is parted from it by several layers of muscular flesh, so that it lies flat, and glides upon the trunk.

The **SCAPULA** is a thin bone, which has originally, like the skull, two tables, and an intermediate diploe; but by pressure, and the action of its own muscles, it grows gradually thinner, its tables are more and more condensed, till in old age it has become perfectly transparent, and is supported only by its processes, and by its thicker edges; for its **SPINE** is a ridge of firm and strong bone, which rises very high, and gives a broad origin and support for its muscles. The **ACROMION** in which the spine terminates, is a broad and flat process, a sure guard for the joint of the shoulder. The **CORACOID** process is a strong but shorter process, which stands out from the neck of the bone: and the **COSTA**, or borders of the bone, are also rounded, firm, and strong, so that the processes and borders support the flat part of the bone, which is as thin as a sheet of paper, and quite transparent.

There is no part nor process of the scapula which does not require to be very carefully marked ; for no accidents are more frequent than luxations of the shoulder ; and the various luxations are explained best by studying in the skeleton, and being able to recognize on the living body all the processes and projecting points.

The **FLAT SIDE** of the scapula is smooth, somewhat concave, and suited to the convexity of the ribs : it is sometimes absurdly called **VENTER**. The scapula is connected with no bone of the trunk, tied by no ligaments, is merely laid upon the chest, with a large mass of muscular flesh under it, upon which it glides ; for there are below it two layers of muscles, by one of which the shoulder-bone is moved upon the scapula, while by the other, the scapula itself is moved upon the ribs. The muscle, lying in the hollow of the scapula, marks it with many smooth hollows, and wave-like risings, which are merely the marks of the origin of its muscles, but which were mistaken even by the great Vesalius for the impressions of the ribs.

The upper flat surface is like the lower one, but that it is traversed by the **SPINE**, which is a very acute and high ridge of bone : it is called the **DORSUM**. Now the spine thus traversing the bone from behind forwards, divides its upper surface into two unequal parts, of which the part above the spine is smaller, and that below the spine is larger. Each of these spaces has its name, one *supra spinatus*, and the other *infra spinatus* ; and each of them lodges a muscle, named, the one the *musculus supra spinatus scapulæ*, as being above the spine ; the other *musculus infra spinatus scapulæ*, as being below the spine. A third muscle is named *subscapularis*, as lying under the shoulder-blade, upon that concave surface which is towards the ribs ; so that the whole scapula is covered with broad flat muscles, whose offices are to move the shoulder-bone in various directions, and which impress the scapula with gentle risings and hollows on its upper as well as on its lower surface.

The **TRIANGULAR** form of the scapula must be next observed. The upper line of the triangle is the shortest ; it is named the **COSTA** or border. This superior costa of the scapula receives those strong and flat muscles that raise the shoulder upwards. On this superior edge is seen the notch, through which a nerve, and sometimes an artery passes. The lower, border which is named the **COSTA INFERIOR**, or the lower border of the scapula, receives no muscles ; because it must be quite free, to move and glide as the scapula turns upon its axis, which is, indeed, its ordinary movement. But it gives rise to two smaller muscles, which, from being a little rounded, are named the

musculi teretes, which round muscles being implanted into the arm-bone, pull it downwards.

The long side of the scapula, which bounds its triangular form backwards, is named the *BASIS* of the *SCAPULA*, as it represents the base of the triangle. This line is also like the two borders, a little thicker or swelled out; and this edge receives many powerful muscles, which lie flat upon the back, and coming to the scapula, in a variety of directions. can turn it upon its axis, sometimes raising, sometimes depressing the scapula; sometimes drawing it backwards; and sometimes fixing it in its place, according to the various sets of fibres which are put into action.

The angles of the scapula are two, the superior more obtuse, and the inferior more acute. From the inferior angle the *teres major* takes its origin, and the outer surface of the bone is made smooth by the passage of the *latissimus* muscle.

The *GLENOID OF ARTICULATING CAVITY* of the scapula, is on the point or apex of this triangle. The scapula is more strictly triangular in a child, for it terminates almost in a point or apex; and this articulating surface is a separate ossification, and is joined to it in the adult. The scapula towards this point terminates in a flat surface, not more than an inch in diameter, very little hollowed, and scarcely receiving the head of the shoulder-bone, which is rather laid upon it than sunk into it: it is indeed deepened a little by a circular gristle, which tips the edges or lips of this articulating surface, but so little, that it is still very shallow and plain, and luxations of the shoulder are infinitely more frequent than of any other bone.

This head, or glenoid cavity of the scapula, is planted upon a narrower part, which tends towards a point, but is finished by this flat head; this narrower part is what is named the *NECK* of the *SCAPULA*, which no doubt sometimes gives way, and breaks. A rough line bordering the glenoid cavity receives the capsular ligament, or rather the capsule arises from that bordering gristle, which I have said tips this circle.

The *SPINE* of the *SCAPULA* is that high ridge of bone which runs the whole length of its upper surface, and divides it into two spaces for the origin of the *supra* and *infra spinatus* muscles. It is high, and very sharp, standing up at one place to the height of two inches. It is flattened upon the top, and with edges, which turning a little towards either side, give rise to two strong fasciæ (*i. e.*) tendinous membranes, which go from the spine, the one upwards to the upper border of the scapula, the other downwards to the lower border: so that by these strong membranes, the scapula is formed into two triangular cavities, and the *supra* and *infra spinatus* muscles rise not

only from the back of the scapula, and from the sides of its spine, but also from the inner surface of this tense membrane. The spine traverses the whole dorsum, or back of the scapula; it receives the trapezius muscle, that beautiful triangular muscle which covers the neck like a tippet, whence it has its name; and the spine beginning low at the basis of the scapula, where a certain triangular space may be observed, gradually rises as it advances forwards, till it terminates in that high point or promontory which forms the tip of the shoulder, and overhangs and defends the joint.

This high point is named the ACROMION PROCESS. It is the continuation and ending of the spine, which at first rises perpendicularly from the bone, but by a sort of turn or distortion, it lays its flat side towards the head of the shoulder-bone: here it is hollow, to transmit the supra and infra spinati muscles. At this place, it is thickened, flat and strong, overhangs and defends the joint, and is not merely a defence, but almost makes a part of the joint itself; for, without this process, the shoulder-bone could not remain a moment in its socket; every slight accident would displace it. The acromion prevents luxation upwards, and is so far a part of the joint, that when it is full under the acromion, the joint is safe; but when we feel a hollow, so that we can push the points of the fingers under the acromion process, the shoulder is luxated, and the socket empty. The point of the acromion forming the apex of the shoulder, a greater projection of this point, and a fulness of the deltoid muscle which arises from it, is a chief cause, and of course a chief mark of superior strength.

But there is still another security for the joint; for there arises from the neck of the scapula, almost from the border of the socket, and its inner side, a thick, short and crooked process, which stands directly forwards, and is very conspicuous; and which, turning forwards with a crooked and sharp point, somewhat like the back of a crow, is thence named the CORACOID PROCESS. This also guards and strengthens the joint; though it cannot prevent luxations, it makes them less frequent, and most probably when the arm is luxated inwards it is by starting over the point of this defending process. This process has three surfaces for the attachment of muscles.

Now the glenoid surface, and these two processes, form the cavity for receiving the shoulder-bone. But still, as if nature could not form a joint at once strong and free, this joint, which performs quick, free, and easy motions, is too superficial to be strong. Yet there is this compensation, that the shoulder-joint, which could not resist, if fairly exposed to shocks and falls, belongs to the scapula, which, sliding easily upon the ribs, yields,

and so eludes the force. Falls upon the shoulder do not dislocate the shoulder; that accident almost always happens to us in putting out the hand to save ourselves from falls; it is luxated by a twisting of the arm, not by the force of a direct blow.

THE CLAVICLE.—The clavicle, or collar-bone, named clavicle from its resemblance to an old fashioned key, is to the scapula a kind of hinge or axis on which it moves and rolls; so that the free motion of the shoulder is made still freer by the manner of its connexion with the breast.

The clavicle is placed at the root of the neck, and at the upper part of the breast; it extends across from the tip of the shoulder to the upper part of the sternum; it is a round bone, a little flattened towards the end which joins the scapula; it is curved like an *Italic*, having one curve turned out towards the breast; it is useful as an arch supporting the shoulders, preventing them from falling forwards upon the breast, and making the hands strong antagonists to each other, which, without this steadying, they could not have been.

The thoracic end, that end next the sternum, or what may be called the inner head of the clavicle, is round and flat, or button-like; the articulating surface is triangular, and is received into a suitable hollow on the upper piece of the sternum. It is not only like other joints surrounded by the capsule or purse: it is further provided with a small moveable cartilage, which (like a friction-wheel in machinery) saves the parts, and facilitates the motion, and moves continually as the clavicle rolls. From this inner head there stands out an angle, which, when the clavicles are in their places, gives attachment to the interclavicular ligament; it ties them to the sternum and to each other. The lower surface has a groove in it for the subclavius; the upper surface is marked by several muscles.

But the outer end of the clavicle is flattened as it approaches the scapula, and the edge of that flatness is turned to the edge of the flattened acromion, so that they touch but in one single point, this outer end of the clavicle, and the corresponding point of the acromion, are flattened and covered with a crust of cartilage; and on the under surface of, it there is a groove corresponding to the groove under the acromion; there is also a small tubercle for a ligament; but the motion here is very light and quite insensible: they are tied firmly by strong ligaments; and we may consider this as almost a fixed point; for there is little motion of the scapula upon the clavicle; but there is much motion of the clavicle upon the breast; for the clavicle serves as a shaft or axis, firmly tied to the scapula, up-

on which the scapula moves and turns, being connected with the trunk only by this single point, viz. the articulation of the clavicle with the breast-bone.

The *OS HUMERI* is one of the truest of the cylindrical bones ; it is round in the middle ; but it appears twisted and flattened towards the lower end ; and this flatness makes the elbow-joint a mere hinge, moving only in one direction. It is again regular and round towards the upper end, dilating into a large round head, where the roundness forms a very free and moveable joint, turning easily in all directions.

The *HEAD* of this bone is very large ; it is a neat and regular circle ; but it is a very small portion of a large circle, so that it is flat ; and this flatness of the head, with the shallowness of its glenoid cavity, makes it a very weak joint, easily displaced and nothing equal to the hip-joint for security and strength.

The *NECK* of this bone cannot fairly be reckoned such ; for, as I have explained in speaking of the neck of the thigh-bone, this neck of the humerus, and the necks of most bones (the thigh-bone still excepted) are merely a rough line close upon the head of the bone, without any straightening or intermediate narrowness, which we can properly call a neck. The roughness round the head of the shoulder bone is the line into which the capsular ligament is implanted.

The *TUBEROSITIES* of the *OS HUMERI* are two small bumps of unequal size, (the one called the greater, the other the smaller tuberosity of the *OS HUMERI*,) which stand up at the upper end of the bone, just behind the head : they are not very remarkable. Though infinitely smaller than the trochanter of the thigh-bones, they serve similar uses, viz. receiving the great muscles which move the limb. The *GREAT-ER TUBEROSITY* is higher towards the outer side of the arm, and receives the *supra spinatus* muscle ; while the *infra spinatus* and *teres minor* muscles, which come from the lower part of the scapula, are implanted into the bone a little lower. The *LESSER TUBEROSITY* has also a great muscle fixed into it, viz. the *subscapularis* muscle.

The two tuberosities form betwixt them a groove, which is pretty deep ; and in it the long tendon of the *biceps* muscle of the arm runs : and as it runs continually, like a rope in the groove of a pulley, this groove is covered in the fresh bones with a thin cartilage, smooth, and like the cartilages of joints. On the outside of this groove there is a ridge for the *pectoralis* on the inside one for the *latissimus*. On the body of the bone, about one third part of its length from the head, there is an irregularity for the attachment of the *deltoid* muscle : and

On the inside of the bone, near its middle, is the hole for the nutritious artery.

The os humeri at its lower part changes its form, is flattened and compressed below, and is spread out into a great breadth of two inches or more; where there is formed on each side a sharp projecting point, (named condyle,) for the origin of great muscles; and in the middle, betwixt the two condyles, there is a grooved articulating surface, which forms the hinge of the elbow. At the lower extremity the bone is somewhat twisted.

At the lower end of the bone, there are two ridges, one leading to either condyle, which it is of some consequence to observe; for the elbow-joint is a mere hinge, the most strictly so of any joint in the body: it has, of course, but two motions, viz. flexion and extension; and it has two muscles chiefly, one for extending, the other for bending the arm: the flexor muscle lies on the forepart, and the extensor on the back part of the arm; and so the whole thickness of the arm is composed at this place of these two muscles and of the bone: but that the fore and back parts of the arm might be thoroughly divided, the bone is flattened betwixt them: and that the division might extend beyond the mere edges of the bone, there are two fasciæ or tendinous webs which go off from either edge of the humeris, and which continue to divide the fore from the back muscles, giving these muscles a broader origin; they are named, from their office, intermuscular membranes; and this is the meaning of the two ridges which lead to the two condyles.

The two projections in which these edges end, are named **CONDYLES**. The condyles of the thigh-bone are the broad articulating surfaces by which that bone is joined with the tibia, while the condyles of the shoulder-bone are merely two sharp projecting points for the origin of muscles, which stand out from either side of the joint, but which have no connexion with the joint. The chief use of the condyles of the shoulder-bone is to give a favourable origin, and longer fulcrum for, the muscles of the fore-arm, which arise from these points. The outer tubercle being the smaller one, gives origin to the extensor muscles, where less strength is required. But the inner tubercle is much longer, to give origin to the flexor muscles with which we grasp, which require a bolder and more prominent process to arise from; for greater power is needed to perform such strong actions as grasping, bending, pulling; while the muscles which extend, the fingers need no more power than just to antagonize or oppose the flexors; their on-

ly business being to unfold or open the hand, when we are to renew the grasp.

It is further curious to observe, that the inner tubercle is also lower than the other, so that the articulating surface for the elbow-joint is oblique, which makes the hand fall naturally towards the face and breast, so that by being folded merely without any turning of the os humeri, the hands are laid across.

The articulating surface which stands betwixt these condyles forms a more strict and limited hinge than can be easily conceived, before we explain the other parts of the joint. The joint consists of two surfaces; first a smooth surface, upon which the ulna moves only backwards and forwards; and secondly, of a small knob upon the inner tubercles, which has a neat round surface, upon which the face or socket belonging to the button-like end of the radius rolls. These two surfaces are called the small head, and the cartilaginous pulley of the humerus.

Belonging to the joint, and within its capsular ligament, there are two deep hollows, which receive certain processes of the bones of the fore arm. One deep hollow on the forepart of the humerus, and just above its articulating pulley, receives the horn-like or coronoid process of the ulna, viz. fossa coronidea; the other receives the olecranon, or that process of the ulna which forms the point of the elbow, viz. fossa olecranalis.

RADIUS AND ULNA.

The radius and ulna are the two bones of the fore arm. The radius, named from its resemblance to the ray or spoke of a wheel; the ulna, from its being often used as a measure. The radius belongs more peculiarly to the wrist, being the bone which is chiefly connected with the hand, and which turns along with it in all its rotatory motions: the ulna, again, belongs more strictly to the elbow-joint, for by it we perform all the actions of bending or extending the arm.

The ULNA is in general of a triangular or prismatic form, like the tibia, and the elbow is formed by the ulna alone; for there is a very deep notch or hinge-like surface, which seems as if it had been moulded upon the lower end of the humerus, embraces it very closely, and takes so sure a hold upon the humerus, that it allows not the smallest degree of lateral motion, and almost keeps its place in the dry skeleton: without the help of ligaments or muscles, it presents, in profile, somewhat of the shape of the letter S, and therefore is named the SIGMOID CAVITY of the ulna. But this sigmoid cavity were a

very imperfect hinge without the two processes by which it is guarded before and behind ; the chief of these is the **OLECRANON**, or large bump, which forms the extreme point upon which we rest the elbow. It is a big and strong process, which checking into a deep hollow on the back of the humerus, serves two curious purposes ; it serves as a long lever for the muscles which extend or make straight the fore arm ; and when by the arm being extended, it checks into its place, it takes so firm a hold upon the hinge or joint of the *os humeri*, as to secure the joint in pulling, and such other actions as might cause a luxation forwards. The other process which guards the elbow-joint is named the **CORONOID PROCESS**, from its horn or pointed form ; it stands up perpendicularly from the upper or forepart of the bone ; it forms the forepart of the sigmoid cavity, and completes the hinge. On the root of the coronoid process there is a rough tubercle for the attachment of the *brachialis internus*. The coronoid process is useful, like the olecranon, in giving a fair hold and larger lever to the muscles, and to secure the joint ; for the arm being extended, as in pulling, the olecranon checks into its place, and prevents luxation forwards ; and the arm again being bent, as in striking, pushing or saving ourselves from falls, the coronoid process prevents luxation backwards ; so the joint consists of the olecranon and the coronoid process as the two guards, and of the sigmoid cavity or hollow of articulation betwixt them ; but the smaller or upper head of the radius also enters into the joint, and lying upon the inner side of the coronoid process, it makes a small hollow there, in which it rolls ; and this second hollow, touching the edge of the sigmoid cavity, forms a double sigmoid cavity, of which the first, or **GREATER SIGMOID CAVITY**, is for receiving the lower end of the humerus ; and the second, or **LESSER SIGMOID CAVITY**, for receiving the upper head of the radius. Betwixt these there is a pit for receiving the glandular apparatus of the joint. The form of the bone being prismatic or triangular, it has like the tibia, three ridges, one of which is turned towards a corresponding ridge in the radius, and betwixt them the interosseous ligament is stretched ; and this interosseous ligament fills all the arch or open space betwixt the radius and ulna, and saves the necessity of much bone ; gives as firm an origin to the muscles as bone could have done, and binds the bones of the fore arm together so strongly, that though the ulna belongs entirely to the elbow-joint, and the radius as entirely to the wrist, they have never been known to depart from each other. On the outside of the greater extremity of the ulna, there is a triangular surface for the attachment of the *anconeus* muscle. The ulna, bigger

at the elbow, grows gradually smaller downwards, till it terminates almost in a point. It ends below in a small round head, which is named the LOWER HEAD of the ulna, which scarcely enters into the joint of the wrist; but being received into a hollow on the side of the radius, the radius turns upon the lower head of the ulna, like an axis or spoke.

Below this little head, the bone ends towards the side of the little finger, in a small rounded point, which is named the STYLOID PROCESS of the ulna; it is chiefly useful in giving a strong adhesion to the ligament which secures the wrist there. And as the styloid process and the olecranon, the two extremities of the ulna, are easily and distinctly felt, the length of this bone has been used as a measure, and so it was named cubitus by the ancients, and is named ulna by us.

RADIUS.—The radius is the second bone of the fore arm, has its position exactly reversed with that of the ulna: for the ulna, belonging to the elbow, has its greater end upwards; the radius, belonging to the wrist, has its greater end downwards; and while the ulna only bends the arm, the radius carries the wrist with a rotatory motion, and so entirely belongs to the wrist, that it is called the *manubrium manus*, as if the handle of the hand.

The BODY of the radius is larger than that of the ulna. The transverse strength of the arm depends more upon the radius which has more body and thickness, is more squared, and is arched in some degree so as to stand off from the ulna, without approaching it, or compressing the other parts. The radius lies along the upper edge of the fore arm, next to the thumb, and being, like the ulna, of a prismatic or triangular form, it has one of its angles or edges turned towards the ulna to receive the interosseous ligament.

The UPPER HEAD of the radius is smaller; of a round, flat-tish, and button-like shape, and lies so upon the lower end of the humerus, and upon the coronoid process of the ulna, that it is articulated with either bone; For, 1st, The hollow of its head is directly opposed to the little head of the *os humeri*; and, 2dly, The flat side of its button-like head rubs and turns upon the side of the coronoid process, making a socket there, which is called the lesser sigmoid cavity of the ulna.

Immediately behind the round flat head, is a narrowness or straightening, called the NECK of the radius; round this neck there is a collar or circular ligament, (named the coronoid ligament of the radius,) which keeps the bone securely in its place, turning in this ligamentous band like a spindle in its bush or socket; for the radius has two motions, first accompanying the ulna in its movements of flexion and extension; and, secondly,

its own peculiar rotation, in which it is not accompanied in return by the ulna; but the ulna continuing steady, the radius moves, and turns the wrist.

Immediately under this neck, and just below the collar of the bone, there is a prominent bump, like a flat button soldered upon the side of the bone, which is the point into which the biceps flexor cubiti, or bending muscle of the fore arm is inserted. On the outside of the bone, and near the middle, there is a roughness for the insertion of the pronator. Where the face of the radius is towards the ulna, there is a long sharp spine for the attachment of the interosseous ligament.

The upper head is exceedingly small and round, while the LOWER HEAD swells out, broad and flat, to receive the bones of the wrist. There are two greater bones in the wrist, which form a large ball, and this ball is received into the lower end of the radius: the impression which these two bones make there is pretty deep, and somewhat of a boat-like shape; whence it is called (like the articulating surface of the tibia) the scaphoid cavity of the radius; it is sometimes partially divided by a ridge; and on the edge of the radius, next to the thumb, the bone ends in a sort of peak or sharper point, which is named, (though with very little meaning,) the STYLOID PROCESS of the radius.

So the scaphoid cavity of the radius forms the joint with the wrist; but there is another small cavity, on the side of the radius, near to the little head of the ulna, into which the lesser head of the ulna is received, and this is enclosed in a proper and distinct capsule. The little head of the ulna does not descend so low as to have any share in forming the wrist. There are properly two distinct joints; the great joint of the wrist, moving upon the radius, the other a little joint within this of the radius, rolling upon the ulna, and carrying the wrist along with it. On the flat extremity of the radius, we find a ridge in the groove; on each side of this spine the extensor tendons run. The extensors of the thumb also make impressions.

OF THE HAND AND FINGERS.

THE wrist is the most complex part of all the bony system, and is best explained in a general way, by marking the three divisions of the hand, into the carpus, or wrist bones; the metacarpus, or bones that stand upon the wrist; and the fingers, consisting each of its three joints. 1. The carpus, or wrist, is a congeries of eight small bones, grouped together, into a very narrow space, very firmly tied together, by cross liga-

ments, making a sort of ball or nuclæus, a solid foundation, or centre of the rest of the hand. 2. The metacarpus is formed of five long bones, founded upon the carpal bones, and which, departing from that centre in somewhat of a radiated form, give, by their size and strength, a firm support to each individual finger, and by their radiated or spoke-like form allow the fingers freer play. 3. The fingers, consisting each of three very moveable joints, are set free upon the metacarpus, so as to show a curious gradation of moving in all these parts; for the carpal bones are grouped together into a small nuclæus, firm, almost immoveable, and like the knave of a wheel; then the metacarpal bones founded upon this are placed like the spokes or fellys of the wheel, and having a freer motion; and, lastly, the fingers by the advantage of this radiated form, in the bones upon which they are placed move very nimbly, and have a rotatory as well as a hinge-like motion; so that the motion is graduated and proportioned in each division of the hand; and even where there is no motion, as in the carpus, there is an elasticity, which, by gentle bendings, accommodates itself to the more moveable parts.

The CARPUS, or WRIST.—Looking upon the external surface of the carpus, we count eight small bones disposed in two rows, with one bone only a little removed from its rank; and we observe that the whole is arched outwards to resist injuries, and to give strength; and that the bones lie like a pavement, or like the stones of an arch, with their broader ends turned outwards. On the internal surface, again, we find the number of bones not so easily counted; for their smaller ends are turned towards the palm of the hand, which being a concave surface, the narrow ends of the wedges are seen huddled together in a less regular form, crowded, and lapped over each other; but in this hollow, the four corner bones are more remarkable, projecting towards the palm of the hand, so as to be named processes: and they do indeed perform the office of processes; for there arises from the four corner points a strong cross ligament, which binds the tendons down, and makes under it a floor or gutter for them to run in.

The individual bones of the carpus are small, cornered, and very irregular bones, so that their names do but very poorly represent their form. To describe them without some help of drawing, or demonstration, is so very absurd, that a description of each of them seems more like a riddle, than like a serious lesson: it cannot be understood, and indeed it need hardly be remembered; for all that is useful, is but to remember the connexion and place, and the particular uses of each bone; in reading of which, the student should continually re-

turn to the plates, or he must have the bones always in his hand.

1. ROW FORMING THE WRIST : viz.

OS SCAPHOIDES, LUNARE, CUNEIFORME, MAGNUM, PISIFORME.

OS SCAPHOIDES.—The boat-like bone. This name of boat-like bone, or boat-like cavity, has been always a favourite name though a very unmeaning one. The scaphoid bone is not worthy of notice merely from its being the largest, but also as it forms a chief part of the joint of the wrist; for it is this bone which is received into the scaphoid cavity of the radius: it is a very irregular bone, in which we need remember only these points; the large round surface covered with cartilage, smooth and answering to the cavity in the head of the radius; the hook-like or projecting process, which forms one of the corner points of the carpus, and gives a hold to one corner of the ligament which binds down the tendons of the wrist. There is also a furrow for the capsular ligament; the concavity from which this bone takes its name, and by which it is articulated with the trapezium and trapezoides, and on its inner surface an oval cavity for the os magnum.

The **OS LUNARE** is named from one of its sides being somewhat of the shape of a half moon; it is next in size to the scaphoid bone, and is equal to it in importance; for they are joined together, to be articulated with the radius. This bone takes an equal share in the joint with the scaphoid bone; and together, they form a great ball, fitting the socket of the radius, and of a long form, so that the wrist is a proper hinge. The chief marks of this bone are its greater size, its lunated edge, and its round head forming the ball of the wrist-joint. These are its surfaces:

1. The surface of a semilunar shape, and on the radial side, attached to the last bone.
2. The convex surface for articulation with the radius.
3. The ulnar surface for articulation with the os cuneiforme.
4. The hollow surface for articulation with the os magnum.

The **OS CUNEIFORME**, or wedge-like bone, is named rather perhaps from its situation, locked in among the other bones, than strictly from its form. Its side forming the convex of the hand, is broader; its point towards the palm of the hand is narrower: and so far we may say, it is a wedge-like bone; but it is chiefly so from its situation closely wedged in betwixt the lunare and pisiform bones.

1. We may readily distinguish the surface articulated with the *os lunare*. 2. Opposite to this the surface of attachment of the *os pisiforme*. 3. The further surface, that is, the side most remote from the fore arm, is interposed betwixt this bone and the end of the *ulna*.

The *OS PISIFORME* is a small, neat, and round bone, named sometimes orbicular, or round bone, but oftener pisiform, from its resemblance to a pea. It is placed upon the cuneiform bone, and it stands off from the rest into the palm of the hand, so as to be the most prominent of all the corner bones; of course, it forms one of the corner points or pillars of that arch, under which the tendons pass. The pisiform bone is a little out of its rank, is very inmoveable, and projects so into the palm, as to be felt outwardly, just at the end of the styloid process of the *ulna*; it can be easily moved and rolled about, and is the point into which the ligament of the wrist is implanted, and the *flexor carpi radialis*, one of the strong muscles for bending the wrist.

2. ROW SUPPORTING THE METACARPAL BONES : VIZ. *OS TRAPEZIUM*, *TRAPEZOIDES*, *MAGNUM ET UNCIFORME*.

The second row begins with the *TRAPEZIUM*, a pretty large bone, which, from its name, we should expect to find of a regular square form; while it has in fact, the most irregular form of all, especially when detached from the other bones. The chief parts to be remarked in the bone, are the great socket, or rather the *trochlea* for the thumb: and as the thumb stands off from one side of the hand, this socket is rather on one side. There is also a little process which makes one of the corner points, and stands opposite to the hook of the *unciforme*.

Opposite to the surface of articulation with the thumb, and towards the first row, there is a similunar surface which touches the convexity of the *scaphoides*, and another which articulates with the *trapezoides*. The fourth articulating surface of this bone is opposed to the head of the metacarpal bone of the finger.

The *TRAPEZOIDES* is next to the *trapezium*, is somewhat like the *trapezium*, from which it has its name. It also resembles the cuneiform bone of the first row in its shape and size, and in its being jammed in betwixt the two adjoining bones.

It is articulated by its nearer surface to the *scaphoides*, on its further surface, by two planes, to the metacarpal bone of

the fore finger, on the radial surface to the trapezium, and on the ulnar surface to the os magnum, having thus five planes or surfaces.

The **OS MAGNUM** is named from its great size; not that it is the largest of all, nor even the largest bone of the second row, for the unciforme bone is as big; but there is no other circumstance by which it is well distinguished. It is placed in the centre of the upper row, has a long round head, which is jointed with the socket formed of the os lunare and scaphoides; on the radial surface the magnum is articulated with the trapezoides; on the ulnar surface with the unciforme; on the further surface it has three planes, and receives the whole head of the metacarpal of the middle finger, and part of the metacarpal of the fore finger and of the ring finger.

The **OS UNCIFORME**, or hook-like bone, is named from a flat hook-like process, which projects towards the palm of the hand. This is one of the corner bones, and standing in the end of the row, it is wedged betwixt the os magnum of its own row, and the os lunare and cuneiform of the first row. It is large and squared; but the thing chiefly remarkable is that process from which it takes its name; a long and flat process of firm bone, unciforme, or hook-like, and projecting far into the palm of the hand, which being the last and highest of the corner points, gives a very firm origin to the great ligament by which the tendons of the wrist are bound down. On its further surface, it has two articulating surfaces corresponding with the metacarpal bones of the ring and middle fingers.

All these bones of the carpus, when they are joined to each other, are covered with a smooth articulating cartilage, are bound to each other by all forms of cross ligaments, and are consolidated, as it were, into one great joint. They are in general so firm as to be scarcely liable to luxation; and although one only is called cuneiform, they are all somewhat of the wedge-like form, with their broader ends outwards, and their smaller ends turned towards the palm of the hand; they are like stones in an arch, so that no weight nor force can beat them in; if any force do prevail, it can beat others in only by forcing one out. A bone starting outwards, and projecting upon the back of the hand, is the only form of luxation among these bones, and is extremely rare.

METACARPUS.—The metacarpus is composed of four bones, upon which the fingers are founded. They are big, strong bones, brought close together at the root, but wider above; for the lower heads are small and flat, and grouped very closely together, to meet the carpal bones. But they

swell out at their upper ends into big round heads, which keep the bones much apart from each other. Nothing of importance can be said concerning the individual bones. To speak of them individually is a mere waste of time. We may observe of the metacarpal bones in general; 1. That their nearer heads, being flat and squared, gives them a firm implantation upon their centre or *nucleus*, the carpus; and they have scarcely any freer motion upon the carpal bones, than the carpal bones have upon each other. 2. Their further heads are broader, whereby the articulating parts of the bone are kept apart, which gives freedom to the lateral motions of the bones of the fingers. 3. Each metacarpal bone is slightly bent; 4. and being smaller, in the middle, there is a space left betwixt the bones for the lodgement of the *interossii* muscles. 5.—These bones taken collectively still preserve the arched form of the carpal bones, being, with the carpal bones, convex outwardly, and concave inwardly, to form the hollow of the hand; and though they have little motion of flexion or extension, they bend towards a centre, so as to approach each other, increasing the hollowness of the hand, to form what is called *Diogenes's cup*. 6. The articulating heads of the further extremities of these bones are flattened, or somewhat grooved, for the play of the tendons of the *interossii* muscles. It is farther necessary to observe, into how small a space the carpal bones are compressed, how great a share of the hand the metacarpal bones form, and how far down they go into the hollow of the hand. For I have seen a surgeon, who, not having the smallest suspicion that their lower ends were so near the wrist as they really are, has, in place of cutting the bone neatly in its articulation with the carpus, broken it, or tried to cut it across in the middle.

FINGERS.—We commonly say that there are five metacarpal bones; in which reckoning we count the thumb with the rest: but what is called the metacarpal of the thumb is properly the first phalanx, or the first proper bone of the thumb, so that the thumb, regularly described, has, like the other fingers, three joints.

THUMB.—The first bone of the thumb resembles the metacarpal bones in size and strength, but it differs widely in being set upon the carpus, with a large and round head; in being set off from the line of the other fingers, standing out on one side, and directly opposed to them, it rolls widely and freely: it is opposed to the other fingers in grasping, and, from its very superior strength, the thumb is named *pollex*, from *pol-lere*.

The FINGERS have each of them three bones :—1. The first bone is articulated with the metacarpal bones by a ball and socket ; the socket, or hollow on the lower part of the first finger-bone, being set down upon the large round head of the metacarpal bone. 2. The second and third joints of the fingers are gradually smaller, and though their forms do a good deal resemble the first joint ; they are quite limited in their motions ; have no rolling ; are as strictly hinge-joints as the knee is. 3. Here, as in other hinge-joints, the capsule is so particularly strong at the sides, as to be named lateral ligaments. When these lateral ligament are burst or cut, the finger turns in any direction ; so that the motions of the fingers are limited rather by their lateral ligaments, than by any thing peculiar in the forms of the bones. 4. The face of each finger-bone is grooved, so that the tendons, passing in the palm of the hand run upwards along this groove or flatness of the fingers ; and from either edge of this flatness there rises a ligament of a bridge-like form which covers the tendons like a sheath, and converts the groove into a complete canal. 5. The last joint or phalanx of each finger is flattened, rough, and drawn smaller gradually towards the point of the finger ; and it is to this roughness that the skin and nail adhere at the point.

OF THE TEETH.*

THE structure, and growth, and decay of the teeth, forms a subject of considerable interest as it gives principles to guide the operations of the dentist, and chiefly as it affords some very remarkable phenomena illustrative of the animal economy.

Considering the teeth generally, as belonging to man and brutes, they are for masticating the food ; they are for retaining the prey ; they are weapons of defence ; in some classes they are for digging and searching for food ; and in some animals we can see no other use than for defending the eyes, as in the *sus æthiopica*. Nor are we to consider them as exclusively belonging to the jaws, for they are sometimes seated in the back part of the mouth ; and in fishes, we find them in the beginning of the œsophagus, or at its termination, as in the crab and lobster.

* By Charles Bell.

The teeth differ from common bone : they are harder; they are covered with a peculiar substance, the enamel, which is not found elsewhere in the body : though they stand exposed, they do not suffer as bone would do in the same circumstances ; though worn by friction, they are not excited to diseased action ; their mode of formation is peculiar, and so is the manner of their decay, and all these instances of their being different from common bone, are so many reasons for instituting a distinct inquiry into their structure.

DESCRIPTION OF THE HUMAN ADULT TEETH.

The human adult teeth are divided into four orders. 1. The INCISORES. 2. The CUSPIDATI OR CANINI. 3. The BICUSPIDES. 4. The MOLARES OR GRINDING TEETH.

The incisores are four in number in each jaw. Every tooth has three parts ; the crown, neck, and fang or root. The crown of the incisor tooth is a wedge having its anterior and posterior surface inclined and meeting in a sharp edge. On the forepart the surface is convex ; on the inside the surface is concave ; and viewing the tooth laterally, it is broader and flat near the neck, and rising pyramidal towards the cutting edge. The cortex or enamel covers the crown of the tooth ; it descends on the back and anterior surface further than on the side. The fangs of the incisores are long and straight, and of a pyramidal form, so that they are deeply socketed in the jaw.

From their position in the jaw, the upper incisor teeth project more than the lower, and, in chewing, their edges do not meet. They pass each other so as to cut, and yet do not meet, and this prevents the rapid wasting of the edge which would otherwise take place, as we see in the horse.*

The incisor teeth of the horse, being subject to attrition, have a provision against this, in the cavity lined with enamel, which is observed in their centre ; nevertheless, we see them worn down even below the bottom of that cavity ; thus the surface of the tooth is smooth, and the horse has lost the mark.

In some animals, as in the rodentia, the front teeth are still better formed for cutting, but as they suffer attrition, and in order to preserve the outer edge sharp, they have a peculiar structure. They are so deeply socketed, that they reach the

* And as indeed we sometimes see in the human teeth. See specimens in my Collection.

whole length of the jaw, and they are provided with a continual growth from behind, which pushes the tooth out in proportion as it is worn away on the forepart. The enamel in these animals is more accumulated on the anterior edge of the tooth, so that the edge stands up fine and sharp.

The *CUSPIDATI*, or *CANINE TEETH*, are next in order, counting backwards. They are two in number in each jaw. They have a general resemblance to the incisor teeth, for when their points are worn off, they are hardly distinguishable. Their fangs are longer, and being the corner teeth of the jaw, and deep socketed, they form the strength of the front teeth. Their principal distinction is in the form of the upper part of the crown, which is like a spear, having a point with two lateral shoulders.

In the larger carnivorous mammalia, this order of teeth are of terrific length, whilst the front teeth are small and carved. The spiral tusk of the narwhal and the tusks of the walrus belong to this division of the teeth: so does the tusk of the barbiroassa, which project in a spiral direction. The use of these teeth Blumenbach cannot comprehend, but Sir Everard Home conceives, that they are provided to defend the eyes of the animal as it rushes through the underwood. There is a small imperfect tooth, called the tush, in a horse, which belongs to this order of teeth, as it is placed betwixt the incisors and the grinding teeth.

The *BICUSPIDES* are four in each jaw: they stand betwixt the canine teeth and the grinding teeth, and in form are intermediate betwixt these two orders. They are sometimes called the lesser molares, being in truth grinding teeth. The crown of the bicuspid rises in two sharp points, so that they are like two cuspidati incorporated, and their fangs prove this to be the case; for whilst they are always flatter and shorter than those of the cuspidati, they have often a division, and sometimes there are distinctly two fangs; their roots are oftener curved than those of the other teeth. The second bicuspid is sometimes wanting.

MOLARES or *GRINDING TEETH*, are six in each jaw. The form of the crown is an oblong square. They have four or more projections on their upper surface, and they are covered with enamel to a uniform level. The lower grinders have two broad fangs, and those of the upper jaw three.

The molares are best considered as cuspidati united, in which idea four cuspidati are incorporated to form one grinder. The projections on the grinding surface correspond with the points of the cuspidati, and the fangs correspond with the projections of the crown; for although there are only two or three

roots to each grinding tooth, yet we may discover that there would be always four fangs if they were disjoined.

The term grinder is not good in comparative anatomy, for in brutes of prey they are compressed, and terminate in three sharp processes, and these in the closing of the jaw intersect each other like the blades of scissars.

These four orders make the full number of thirty-two in the adult jaws.

OF THE FIRST SET OF THE TEETH, THE MILK OR DECIDUOUS TEETH.

The first set of teeth are twenty in number : these are divided into three classes ; the *INCISORES*, four in each jaw ; the *CUSPIDATI*, two in each jaw ; and the *MOLARES*, four in number in each jaw.

The teeth of a child generally appear in this order : first the central incisors of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. These in a few weeks are succeeded by the lateral incisors of the lower jaw ; then the lateral incisors of the upper jaw, though sometimes the lateral incisors of the upper jaw appear before those of the lower jaw. The growth of the teeth is not after this in a regular progression backwards ; for now, instead of the cuspidati, which are immediately lateral to the incisors, the anterior molars of the lower jaw show their white surface above the gum about the fourteenth or fifteenth month. Then the cuspidati pierce the gum ; and lastly, the larger molars make their appearance, the teeth of the lower jaw preceding those above. The last tooth does not rise till the beginning of the third year.

The teeth do not always cut the gum in this order ; but it is the more regular and common order. When the teeth appear in irregular succession, more irritation and pain, and more of those symptoms which are usually attributed to teething, are said to accompany them.

The deciduous set of teeth terminates with the rising of the second molaris ; for the third molaris being formed about the eighth year, when the jaw is advanced towards its perfect form, is not shed, but is truly the first permanent tooth. The molars of the adult are properly the permanent teeth (*IMMUTABILES*,) for they alone arise in this part of the jaw, and remain in their original places ; yet we must recollect that, in opposition to Albinus, in this arrangement, it is more common to speak of the whole set of the adult teeth as the *immutabiles*.

In the sixth and seventh years the jaws have so much enlarged, that the first set of teeth seems too small, spaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the shedding of the teeth is by no means regular in regard to time; the child is already no longer in a state of nature, and a thousand circumstances have secretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, so frequently are some of them retained altogether, that it would appear necessary to be assured of the forward state of the adult tooth before the tooth of the first set should be thoughtlessly drawn.

The jaw-bones are still so small, that the second set of teeth must rise slowly and in succession, else they would be crowded into too small a circle, and of course turned from their proper direction.

The incisores of the under jaw are loose commonly when the anterior of the permanent molares are thrusting up the gum. The permanent central incisores soon after appear, and in two or three months more those of the upper jaw appear. In three or four months the lateral incisores of the lower jaw are loose, and the permanent teeth appear at the same time with the anterior molares. The lateral incisores of the upper jaw follow next; and in from six to twelve months more, the temporary molares loosen, the long fangs of the cuspidati retaining their hold some time longer.

The anterior molaris and the cuspidati falling, are succeeded about the ninth year by the second of the bicuspidæ and the cuspidati. The posterior of the bicuspidæ take place of the anterior molares about the tenth or eleventh year; the second permanent molaris does not appear for five or six years from the commencement of the appearance of the permanent teeth. The jaw requires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens sapientiæ*, makes its appearance. This tooth is shorter and smaller, and is inclined more inward than the others. Its fangs are less regular and distinct, being often squeezed together. From the cuspidati to the last grinder, the fangs are becoming much shorter, and from the first incisor to the last grinder, the teeth stand less out from the sockets and gums.

OF THE STRUCTURE OF THE TEETH.

A tooth consists of these parts:—The ENAMEL, a peculiarly hard layer of matter composing the surface of the body of the

tooth. The internal part, or inner substance of the tooth, is less stony and hard than the enamel, but of a firmer structure and more compact than common bone. In regard to the form of the tooth, we may observe, that it is divided into the crown, the neck, and the fangs, or roots of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth, and the tube of the fangs communicates with it. This cavity receives vessels for supplying the remains of that substance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called *gomphosis*. They are not firmly wedged into the bone, for in consequence of maceration, and the destruction of the soft parts, the teeth drop from the skull.—There is betwixt the tooth and its socket in the jaw a common periosteum.

OF THE ENAMEL. The surface of a tooth, that which appears above the gum, is covered with a very dense hard layer of matter, which has been called the enamel.* In this term there is some degree of impropriety, as assimilating an animal production with a vitreous substance, although the enamel very widely differs from the glassy fracture when broken. This matter bestows the most essential quality of hardness on the teeth; and when the enamel is broken off, and the body of the tooth exposed, the bony part quickly decays.

The enamel is the hardest production of the animal body. It strikes fire with steel: in church-yard skulls it is observed to remain undecayed when the centre of the tooth has fallen into dust. It has been found that the component parts of the enamel are nearly the same with those of bone. In bone the phosphate of lime is deposited on the membranes, or cartilage, but this hardening matter of bones is a secretion from the vessels of the part, and is accumulated around the vessels themselves: it is still within the control of their action, and is suffering the succession of changes peculiar to a living part. In the enamel, the phosphate of lime has been deposited in union with a portion of animal gluten, and has no vascularity, nor does it suffer any change from the influence of the living system. Although the hardening matter be principally phosphate of lime, a small proportion of the carbonate of lime enters into the composition both of bone and of enamel. But in enamel, according to Morichini and Gay Lussac, there is fluat of lime, to which ingredient these chemists attribute the hardness of this crust.†

* In brutes there is a considerable variety in the relative form of the enamel and bone of the tooth.

† By Mr. Hatchett's Experiments, (*Philos. Transact.* 1799,) we learn that bone consists of phosphate of lime, with a small proportion of carbonate of lime. The

Although we call the earthy deposit, the hardening matter, yet it is the union of the glutinous matter which bestows the extreme hardness, for, when the tooth is as yet within the jaw, and in an early stage of its formation, the deposition is soft, and its surface rough : but by a change of action in the surface, which throws out this secretion, the first deposition is penetrated with gelatinous secretion, which either by this penetration simply, or by causing a new apposition of its parts, (its structure indeed looks like chrystallization,) bestows the density and extreme hardness on this crust.

When an animal is fed with madder, the colouring matter coming in the course of the circulation, in contact with the earth of bone, is attracted by it and is deposited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body ; and, as by this process of feeding, the enamel is not tinged, we have a convincing proof that the vascular system has no operation, on the enamel after it is formed.

In the marmot, beaver, and squirrel, the enamel is of a nut brown colour, on the anterior surface of the incisor teeth. The molares of some of the cloven-hoofed animals are covered with a black vitreous matter, and sometimes they have a crust of a shining substance like bronze. In the grinding teeth of the granivorous animals, the arrangement of the enamel is quite peculiar.

From the composition of the enamel, we must be aware of the bad effect of acidulated washes and powders to the teeth ; they dissolve the surface, and give a deceitful whiteness to the teeth ; they erode the surface, which it is not in the constitution of the part to restore.

OF THE CENTRAL BONY PART OF THE TOOTH.

The chemical composition, and the manner of combination shell of the crab and lobster consists of phosphate of lime and carbonate of lime, the latter being in the greatest quantity. The testaceous shells consist entirely of carbonate of lime. The matter of bone and teeth consists of phosphate of lime and a small portion of carbonate deposited in the interstice of an animal substance which is of the nature of cartilage, and proves to be gelatine. The bones of fish differ from those of man and brutes, in the larger proportion of animal substance. These chemical facts are, however, of little import to the anatomist : he is desirous of knowing what property of life these parts are endowed with ; whether they are formed by a final deposition, or are still under the influence of the circulating vessels, whether they possess a principle of self-preservation independent of vascularity, or are like common dead matter altogether out of the system.

The formation of bone has been very fully described. The formation of shell is more like that of teeth. The testaceous shell consists of layers ; the layers are formed successively by secretion from the animal body, and each successive layer is broader than the preceding, answering to the increased circumference of the animal. Reaumeur broke the shell of a snail, and he found that when he covered the surface of the creature and prevented the exudation, no shell was formed. There has been a question agitated regarding the possibility of nutrition, without the intervention of vessels, which bears upon this subject, of the nature of shell and teeth.

of the matter forming the central part of the tooth, and of the fangs, is similar to other bones of the body ; but when we examine the hardness and the density of the tooth, and see that it is not even porous, or apparently capable of giving passage to vessels, we conclude that it is not vascular, and are apt to suppose that it holds its connexion with the living jaw-bone by some other tenor than that of vessels, or the circulation of the blood through it. The body and fangs of a tooth are covered with a periosteum like other bones. The vascularity of the periosteum, which surrounds the tooth, and the vessels which enter by the fangs to the cavity of the tooth, seem to be a provision for supplying them plentifully with blood ; but on further examination, it will prove to be a means only of fixing the tooth in the socket, and of preserving the sensibility of the nerve in the cavity of the tooth. As the bony part of the tooth has often been coloured by feeding young animals with madder, it might deceive some to suppose that there is blood circulating through the body of the tooth, and that the tooth undergoes the same changes by absorption which the other bones are proved to do. But these experiments may have been made while the teeth were forming by a secretion from the pulp, and of course they might be coloured without the experiment affording a fair proof that the circulation continues in the tooth after it is formed.

OF THE VASCULARITY AND CONSTITUTION OF THE BONY PART OF THE TOOTH

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, transparent, and brittle with old age ; and when a tooth has been knocked from its socket, and replaced, dentists have observed that it loses its whiteness and assumes a darker hue.

The absorption of the roots in consequence of the caries of the body of the tooth, and the absorption of the fangs of the deciduous teeth, are further alleged in proof of their vascularity ; not only the pressure of the rising tooth on the fangs of the temporary teeth will cause an absorption of the latter, but the fangs of the temporary teeth will waste and be absorbed, so as to drop out without the mechanical pressure of the permanent teeth, and before they have advanced to be in contact with the former.

The teeth seem acutely sensible ; but a little consideration teaches us that the hard substance of the teeth is not endowed

with sensibility, and that it must be the remains of the vascular pulp, presently to be described, occupying the centre of the tooth, which being supplied with nerves, gives the acute pain in tooth-ache. It is a medium communicating or abstracting heat; that the tooth itself gives pain. When wrought upon by the dentist, no sensation is produced unless the tremor be communicated to the centre, or unless the abrading, or cutting instruments, be so pried as to heat the tooth; then an acute pain is produced from the heat communicated to the centre; and so ice or extremely cold liquids, taken into the mouth, produce pain, from the cold affecting the pulp through the body of the tooth.

As living parts, the teeth have adhesion to the periosteum, and are connected with their internal pulp; but when they spoil, and are eroded, the disease spreads inwardly, probably destroying the life of the bony part of the tooth, the progress of which disease is marked by a change of colour penetrating beyond the caries towards the centre of the tooth. When this discolouration has reached the internal surface, the pain of tooth-ach is excited; the pulp vascular, and supplied with nerves, inflames, from a want of accordance with the altered state of the tooth, just as the dead surface of a bone will inflame the central periosteum and marrow. The extreme pain produced by this state of the tooth probably proceeds from the delicate and sensible pulp swelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is discoloured deep in its substance long before the pulp of the central cavity is exposed by the progress of the caries. No exfoliation, or exostosis, takes place upon that part of the tooth which is above the gum, which may be owing to the mere compactness of the ossific depositions.

In the further consideration of this subject, there are circumstances which will make us conclude that there is no vascular action in the teeth, and incline us to believe that they possess a low degree of life, independent of vascular action. Supposing the bony part of the tooth to be avascular, and to possess the principle of life, is not the firm adhesion and contact of the enamel to the body of the tooth a curious instance of a part destitute of life adhering to the surface of a living part without producing the common effects of excitement and exfoliation, or inflammation in the latter?

In rickets, and molities ossium, and other diseases of debility in which the bone wastes, or the growth is retarded, the grown teeth are not altered in their form or properties. The effects which we perceive in the bony system under these

diseases, are produced by the activity of the absorbent prevailing over the action of the red vessels ; while in the teeth no such effect can take place, if they are formed by a deposition of bony matter which is not re-absorbed, nor subject to the revolution of deposition and re-absorption, which takes place in other parts of the body. Accordingly, we find in rickets, where the hardest bone yields, where the jaw-bone itself is distorted or altered in its form, that the teeth remain distinguished for their size and beauty. In molities ossium, I have found the teeth loose, but hard in their substance. In rickets the teeth are large, and perfectly formed, while the jaws are stunted and interrupted in their growth. The consequence of this is, that the teeth form a larger range than the jaw, and give a characteristic protuberance to the mouth.

I must here observe, however, that if a child is in bad health during the formation of the teeth, they are often deficient in form, or in the crust of enamel which covers them, instances of which my reader may see in my Collection.

When an adult tooth of one jaw is lost, there appears to be a growth of the tooth of the opposite jaw ; but I believe the tooth only projects from its socket a little further, in consequence of the want of that pressure to which it is naturally accommodated. The teeth of the *rodentia* are wasted by attrition and seem to grow. This is indeed a growth, but it is of the nature of the first formation of the tooth proceeding from the pulp.*

Much has been said of balls being found in elephants' teeth, as they are found in bones, the bony matter accumulated around the ball, a proof of the inflammation of the tooth, and of course of its vascularity. The specimens in the collections of Haller, Blumenbach and Monro, are quoted. I possess a great variety of these specimens, of both iron and leaden balls immersed in the ivory of the elephant's tusk, but they prove that the pulp continuing to secrete bony matter, has enveloped the ball after it has pierced the shell of the tooth.

The roots of the teeth are sometimes found enlarged, distorted, or with exostosis formed upon them. Again the cavity of the tooth is found filled up with what appears to be new matter, or around the fangs we often find a small sac of pus, which is drawn out in extracting the tooth. Nevertheless, in these examples of disease, there are no unequivocal marks of vascular action in the tooth ; the unusual form, or exostosis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is caused in the same

* See the ingenious Inaugural Dissertation of Dr. Blake.

way, or by the resumed ossific action of the pulp, in consequence of the disease and destruction of the body of the tooth ; and the abscesses which surround the fangs are caused by the death of the tooth, in consequence of which it has lost its sympathy with the surrounding living parts, and becomes a source of irritation like any other foreign body.

The transplanting of teeth presents another very interesting phenomenon. A tooth recently drawn, and placed accurately into a socket from which one has been taken, will adhere there : nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves only that the tooth possesses vitality ; for after it is taken from the natural socket, if it be kept any time it will not adhere : it has become a dead part, and the living substance refuses to unite with it. Again, and in opposition to this, is it not very extraordinary that a tooth may be burnt by chemical agents, or the actual cautery, down to the centre, and yet retain its hold ; or that the body of the tooth may be cut off, and a new tooth fixed into it by a pivot ? Had the teeth any vascular action, this torturing would cause re-action and disease in them. Sometimes the most terrible effects are produced by these operations, as tetanus, abscess in the jaws, &c. ; but this happens in consequence of the central nerve being bruised by the wedging of the pivot in the cavity of the tooth, or by the roots of the tooth becoming, as dead bodies, a source of irritation to the surrounding sockets.

OF THE GUMS.—The necks of the teeth are surrounded by the gums, a red, vascular, but firm substance, which covers the alveolar processes. To the bone and to the teeth the gums adhere very strongly, but the edge touching the tooth is loose. The gums have little sensibility in their healthy and sound state ; and by mastication, when the teeth are lost, they gain a degree of hardness which proves almost a substitute for the teeth. The use of the gum is chiefly to give firmness to the teeth, and at the same time, to give them that kind of support which breaks the jar or bony contact. Like the alveolar process, the gums have a secret connexion with the state of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums,* but this is thrown off, or wastes with the rising of the teeth : and as the teeth rise, the proper gums grow, and embrace them firmly. The gum is firm, and in close adhesion, when the teeth are healthy ; loose, spongy, or shrunk, when they are diseased. The only means of operating upon the general state of the teeth is through the gums ;

* See Herissant.

and by keeping them in a state of healthy action, by the brush and tinctures, the dentist fixes the teeth, and preserves them healthy; but when they are allowed to be loose and spongy, and subject to frequent bleeding, (which is improperly called a scorbutic state,) the teeth become loose, and the gums painful. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or diseased, the gum ulcerates, loosens, and shrinks from it; and this shrinking of the gums is soon followed by the absorption of the socket.

We must conclude, that the whole of the phenomena displayed in the formation, adhesion, and diseases of the teeth, show them to be possessed of life, and that they have a correspondence or sympathy with the surrounding parts. But are we prepared to acquiesce in the opinion of Mr. Hunter, that they possess vitality while yet they have no vascular action within them? We naturally say, how can such vitality exist independently of a circulation? But there are not wanting examples of an obscure and low degree of life existing in animals' ova, or seeds, for seasons without a circulation; and if for seasons, why not for a term of life? We never observe the animal economy providing superfluously; and since there is no instance to be observed in which the teeth have shown a power of renovation, why should they be possessed of vascularity and action to no useful end? All that seems necessary to them is, that they should firmly adhere without acting as a foreign and extraneous body to the surrounding parts, and this vitality, without vascular action, seems calculated to provide.

OF THE FORMATION AND GROWTH OF THE TEETH.

In the jaws of a child newly born, there are contained two sets of teeth as it were in embryo: the deciduous, temporary, or milk-teeth: and the permanent teeth. The necessity for this double set of teeth evidently is to be found in the incapacity of alteration of shape or size in the teeth, as in other parts of the body; the smaller teeth, which rise first, and are adapted to the curve and size of the jaw-bone of an infant, require to be succeeded by others, larger, stronger, and carrying their roots deeper in the jaw.

Each tooth is formed in a little sac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vascular gum, and connect with it.

When we open one of these sacs at an early period of the formation of the tooth, a very curious appearance presents itself: a little shell of bone is seen within the sac, but no ena-

mel is yet formed. Upon raising the shell of bone, which is of the shape of the tooth, and is the outer layer of the bony substance of the tooth, a soft vascular stool, or pulp,* is found to have been the mould on which this outer layer of ossific matter has been formed; and a further observation will lead us to conclude, that this bony part of the tooth is in the progress of being formed by successive layers of matter thrown out from the surface of this vascular pulp; though many have explained the formation of the tooth, by supposing that the layers of this pulp were successively ossified.

If we now turn our attention to the state of those teeth which we know to be later of rising above the gum, we shall find the ossification still less advanced, and a mere point; or perhaps several points of the deposited matter on the top of the pulp.

The pulp, or vascular papilla on which the tooth is formed, has not only this peculiar property of ossification, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its base splits so as to form the mould of two, three, or four fangs, or roots; for around these divisions of the pulp the ossific matter is thrown out so as to form a tube, continued downwards from the body of the tooth. Gradually, and by successive layers of matter on the inside of this tube, it becomes a strong root, or fang, and the bony matter has so encroached on the cavity, that only a small canal remains, and the appearance of the pulp is quite altered, having shrunk in this narrow space.

We have said that the tooth forming on its pulp, or vascular bed, is surrounded with a membrane giving the whole the appearance of a little sac. This membrane has also an important use. It is vascular also as the pulp is, but it is more connected with the gums, and receives its vessels from the surface, while the pulp, lying under the shell of the tooth, receives its blood-vessels from that branch of the internal maxillary which takes its course in the jaw.

The enamel is formed after the body of the tooth has considerably advanced towards its perfect form. It is formed by a secretion from the capsule, or membrane, which invests the teeth,† and which is originally continuous with the lower part of the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter supposed that the capsule always secreting, and the upper part of the tooth being formed first, it would follow, of course, that the

* Le noyau, la coque, or le germe de la dent, by the French authors.

† This outer sac has been called *chorion*, from the numerous vessels distributed upon it. See Herissant.

point and body of the tooth would be covered with a thicker deposition; but it rather appears that that part of the sac opposite to the upper part, and body of the tooth, has a greater power of secreting, being in truth more vascular and spongy; for the whole of the body of the bony part of the tooth is formed before the enamel invests the tooth.

We are indebted to M. Herissant for much of the explanation of the manner in which the enamel is formed. He describes the sac,* its attachment to the pulp and to the neck of the teeth,—as the tooth advances to its perfect form, the sac also changes. At first it is delicate and thin, but it thickens apace. And he asserts, that if after this progress is begun you examine the inner surface of it with a glass, you will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them. This liquid exuded upon the surface of the teeth he supposes to form the enamel. He explains also how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it is inverted, and by still keeping its connexion with the circle of the crown of the tooth, rises up in connexion with the gum, and in some degree forms the new gum which surrounds the tooth.

The sac which encloses the rudiments of the tooth consists of a double membrane. The outer membrane is of a looser texture, and vascular; the inner is vascular also, but delicate and soft. Mr. Hunter said, that while the tooth is within the gum, there is always a mucilaginous fluid, like the sinovia in the joints between this membrane and the pulp of the tooth. I do not imagine that the enamel is produced by the concretion of this humour, which we may find at any period of the growth of the body of the tooth; but that the secreting surface changes the nature of its action, when the bone of the tooth is perfected in its outer layer.

This subject of the formation of teeth would be incomplete if we left unexplained the peculiar structure of the teeth of graminivorous animals.

Mr. Corse, in a curious paper in the Philosophical Transactions of London for the year 1799, describes the grinding tooth of an *elephant* in the following terms: In describing the structure of the grinders, it must be observed, that a grinder is composed of several distinct laminæ or teeth, each covered with its proper enamel; and that these teeth are merely joined to each other by an intermediate softer substance, acting like cement.

* Ressemble assez a une petite bourse fermee.

The structure of the grinders, even from the first glance, must appear very curious, being composed of a number of perpendicular laminæ, which may be considered as so many teeth, each covered with a strong enamel and joined to one another by the common osseous matter. This being much softer than the enamel, wears away faster, by the mastication of the food; and, in a few months after some of these teeth cut the gum, the enamel remains considerably higher, so that the surface of each grinder soon acquires a ribbed appearance, as if originally formed with ridges.

The pulp of graminivorous animals is not shaped like that which forms the human tooth; it consists of several processes united at their base. The capsule has also processes which hang into the interstices of the pulp; the pulp forms a shell of bone which in time covers it. The processes of the capsule, which of course hang into the interstices of this layer of bone, (which has taken the exact form of the pulp,) form over the bone layers of enamel. The tooth now consists of conical processes of bone, united at their roots, and the surfaces of these processes have deposited on them the enamel. The membranous productions of the capsule having completed the enamel, change the nature of their secretion somewhat, and throw out a bony matter, which Dr. Blake has called the *crusta petrosa*. By the formation of this last matter of the tooth the processes which secrete are encroached upon so much, that they shrink altogether, and into the place left by them after they have lost their power of secreting, foreign matter is sometimes introduced by mastication.*

The effect of this formation is to make the layers of the enamel pervade the whole substance of the tooth, the better to make it stand against the continued attrition necessary in the grinding and rumination of the herbivorous and graminivorous animals. The grinding teeth of the purely carnivorous animals, as of the lion and tiger, close like the blades of scissors: they are prevented by the long canine teeth from moving laterally; and as they are not subject to attrition, the enamel only covers their surfaces.

OF THE GROWTH OF THE SECOND SET OF TEETH, AND THE SHEDDING OF THE FIRST.

The first, or deciduous set of teeth, being adapted only for

* See a paper of Mr. Home's in the Philosophical Transactions, and Dr. Blake's Inaugural Dissertation.

the jaws of a child, are destined to be shed, and to give place to the adult, or permanent set of teeth. Accordingly in observing the progress of the formation of the first teeth, the rudiments of the second may also be seen in the fœtus of the seventh or eighth month; and in the fifth and sixth month after birth, the ossification begins in them. The rudiments of the permanent teeth may be observed even when the sac is very small, and appear like a filament stretching up to the neck of the sac of the deciduous teeth.* These sacs lie on the inner side of the jaw-bone, and when further advanced, the necks of the two sacs (both as yet under the gum) are united; but when the first teeth are fully formed, and have risen above the gum, the alveolar processes have been at the same time formed around them, and now the sacs of the permanent teeth have a connexion with the gums through a small foramen in the jaw-bone, behind the space through which the first teeth have risen.

The opinion entertained, that the second set of teeth push out the first, is erroneous, for the change on the deciduous and the growing teeth seems to be influenced by laws of coincidence, indeed, but not of mechanical action. Sometimes we observe the falling tooth wasted at the root, or on the side of the fang, by the pressure of the rising tooth. Now here we should suppose that the newly formed tooth should be the most apt to be absorbed by the pressure of the root of the deciduous tooth, did we not recollect that the new tooth is invested with the hard enamel, while the pressure on the other is upon the bony root. But there is more than this necessary to the explanation of the shedding of the teeth, for often the fang is wasted, and the tooth adheres only by the gum, and the permanent tooth has made little progress in its elevation, and has not pressed upon it.

This decay and wasting of the fangs of the teeth looks more like a satisfactory proof of their vascularity, than any other change to which they are subject. Yet there seems to be no reason why we should not suppose, that as the rudiments of the teeth rise into action at a particular time, and form the bony centre of the tooth, the decomposition should be effected by similar laws: that at a particular period the tooth should decay, and that the decay of the tooth should begin with the destruction of the fangs. Has the bony part of the tooth a tendency to dissolution independently of a circulation of blood through it? and as the roots waste, do the surrounding vascular parts absorb its substance? or does the surrounding vascu-

* See the plate of the Teeth.

lar substance operate on the tooth dissolving, and absorbing it as it is said a dead bone is absorbed, when placed upon an ulcer?

When the internal vascular substance of a tooth is destroyed, it does not waste ; when teeth are pivoted, their roots remain twenty years without wasting or being absorbed ; and when the vascular centre of the milk-teeth is destroyed, their roots waste no more, and they continue adhering to the gum. This seems to point to the internal membrane of the tooth as the means of its absorption.

It is no proof of the first set being pushed out by the second set of teeth, that if the permanent teeth do not rise, the first will remain, their roots unwasted and firm even to old age ; for still I contend, that there is an agreement and coincidence, betwixt the two sets of teeth in their changes, and also in the alveoli, by which they are surrounded ; but this is not produced by the pressure of the rising teeth. When a dentist sees a tooth seated out of the proper line, and draws it, and finds that he has made the mistake of extracting the adult tooth, letting the milk tooth remain, he must not expect that the milk-tooth will keep its place, for the contrary will happen ; it will in general fall out.

The old and the new teeth are lodged in distinct compartments of the jaw-bone, and what is more curious, their alveoli are distinct ; for as the roots of the first teeth decay, their alveolar processes are absorbed, while again, as the new teeth rise from their deep seat in the jaw-bone, they are accompanied with new alveoli ; and the chief art of the dentist in shifting the seat of the teeth, is gradually to push them along the jaw, notwithstanding the bony partitions or alveoli and processes, so as to bring them into equal and seemly lines. It is curious to observe, that the alveoli will, by the falling out of one tooth, or the operation of wedging betwixt the teeth, change their place in the jaw.

When a tooth is lost, it appears as if the space it occupied were partly filled up by an increased thickness of the adjacent teeth, and partly by the lengthening of that which is opposite : indeed, this appearance has been brought as proof of the continual growth of teeth. But there is a fallacy in the observation ; for when the space appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increase of their breadth, but to their moving from that side where they are well supported to the other side where they are not. From this reason they get an inclined direction ; and this inclination may be observed in several of the adjoining teeth.

No circumstance can better illustrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extensive exfoliations. I have a specimen of this in my collection, where the whole circle of the alveolar processes and teeth is thrown off. This happened after the confluent small-pox. I think I recollect a similar case occurring to Dr. Blake. In those tumours which arise from the alveoli and gums, filling the mouth with a cancerous mass, and softening the upper part of the jaw, there is no eradicating the disease but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer base. But even this operation will be too often unsuccessful.

BOOK II.

OF THE MUSCLES.

CHAP. I.

MUSCLES OF THE FACE, EYE, AND EAR.

I. MUSCLES OF THE FACE.

THE OCCIPITO FRONTALIS is a broad and thin muscular expansion, which covers all the upper part of the cranium. It consists of two bellies, with an intermediate sheet of flat tendon. The one belly covers the occiput, the other covers the forehead, and the tendinous expansion covers all the upper part of the head; by which it has happened that the most eminent anatomists, as Cowper, (p. 29.) have misnamed its tendon, pericranium; many have reckoned it two distinct muscles, viz. the OCCIPITAL and FRONTAL, while others (because of a sort of rapha, or line of division in the middle of each belly,) have described four muscles, viz. two frontal, and two occipital muscles. But it is truly a double-bellied muscle; and the broad thin tendon, which belongs equally to both bellies, lies above the true pericranium, and slides upon it. The muscle is therefore named, with strict propriety, occipito-frontalis, sometimes EPICRANIUS, sometimes BIVENTER or DIGASTRICUS CAPITIS.

ORIGIN.—The occipital portion is the fixed point of this muscle arising from the superior transverse ridge of the occipital bone, and covering the back part of the head, from the mastoid process of one side, round to that on the opposite side of the head. And by the perpendicular ridge of the occiput, it is marked with a slight division in the middle.

INSERTION.—The fore belly of the muscle which covers the forehead, is fixed more into the skin and eye-brows than into the bone: it is slightly attached to the bone, near the inner end of the orbitary ridge, and especially about the inner corner of the eye, and the root of the nose, by a smaller and acute

pointed process ; but still its chief attachment is to the eye-lids and skin.

THE TENDON or thin MEMBRANEOUS expansion which joins the two bellies, is exceedingly thin : it has on its inner side much loose cellular substance, by which, though attached to the true pericranium, it slides easily and smoothly upon it ; but its outer surface is so firmly attached to the skin, and its fore belly adheres so firmly to the eye-brows, that it is very difficult to dissect it clean and fair.

I consider the occipital belly as the fixed point, having a firm origin from the ridge of the bone ; its frontal belly has the loose end attached, not to the os frontis, but to the eye-brow and skin, and its office, that of raising the eye-brows, wrinkling the forehead, and corrugating the whole of the hairy scalp, like that muscle under the skins of animals, which shrinks when they are cold or rudely touched, and by which they shake off flies or insects. But it is a muscle more employed in expressing passions, than in performing useful motions, and it is often so thin, as hardly to be perceived. In some it is entirely wanting, and many who have the muscle, have no command nor power over it.

There is a small, neat, and pointed slip of the occipito frontalis, which goes down with a peak towards the nose, and is inserted into the small nasal bone. This process being much below the end of the eye-brow, must pull it downwards ; so that while the great muscle raises the eye-brow and skin of the forehead, this small nasal slip pulls the eye-brow downwards again, restoring it to its place, and smoothing the skin. It may be considered as the antagonist of the great occipital and frontal bellies, and might almost be described as a distinct muscle. It is so mingled with the compressor nasis, and part of the levator labii superioris alæ que nasi, that there is some difficulty in dividing them.

II. The CORRUGATOR SUPERCILII is another slip which might be fairly enough referred, like this, to the occipital muscle ; but being in many subjects particularly strong, it is best described as distinct.* The lower end of the nasal slip of the occipito frontalis is fixed to the nasal bone. The lower end of the little slip, the corrugator supercilli, is fixed into the internal angular process ; and from the inner angle of the eye, the fibres sweep round the edge of the orbit, and going obliquely upwards and outwards, are so mixed with the fibres of the frontal muscle, and of the orbicularis oculi, where these two touch each other, that it is doubtful to which of these

* It lies entirely under the frontal muscle ; it is firmer and smoother in its fibres.

greater muscles this little one might be most properly referred. So this slip of oblique fibres, rising from the inner angle of the eye, and being fixed into the eye-brow, also antagonizes the occipito frontalis, and drawing the eye-brows together, and wrinkling the space betwixt them, is very rightly named *COR-RUGATOR SUPERCILII*. We frequently find a slip running from the outer and lower part of the muscle to join the levator labii superioris proprius.

III. ORBICULARIS OCULI, OF PALPEBRARUM, is a neat and regular muscle, surrounding the eye, and covering the eye-lids in a circular form. It is exceedingly flat and thin; is about an inch in breadth; lies immediately under the skin of the eye-lids, and is immediately attached to them, and but little connected with the bone. It has one small tendon in the inner corner of the eye, which is both its origin and insertion; for it begins and ends in it. This small tendon is easily felt through the skin in the inner corner of the eye. It arises by a little white knot from the nasal process of the upper jaw-bone. Its fibres immediately become muscular, and spread out thin over the upper eye-lid. They pass over it to the outer corner of the eye, where they cross a little, and having covered just the edge of the temple with their thin expanded fibres, they return in a circular form round by the lower eye-lid to the point from whence they had set out. This is, in all its course, a very thin muscular expansion, with regular orbicular fibres. It is rather a little broader over the lower eye-lid, extends itself a little upon the face beyond the brim of the socket, both at the temple, and upon the cheek; and its fibres cross each other a little at the outer angle; so that some understanding this crossing as a meeting of fibres from the upper and from the lower muscle, have described it as two semi-circular muscles. And those fibres which are next to the tarsus or cartilaginous circle of the eye-lids, were distinguished by Riolan, under the title of *MUSCULUS CILIARIS*. Our name expresses the common opinion, that it is a circular muscle, whose chief point or fulcrum is in the inner corner of the eye, and which serves as a sphincter for closing the eye. It squeezes with spasmodic violence, when the eye is injured, as by dust. And by its drawing down the eye-lids so firmly, it presses up the ball of the eye hard into the socket, and forces the lachrymal gland that is within the socket, so as to procure a flow of tears.

IV. LEVATOR PALPEBRÆ SUPERIORIS.—This small muscle arises deep within the socket, from the margin of that hole which gives passage to the optic nerve. It begins by a small flat tendon in the bottom of the optic cavity, becomes gradually broader as it goes over the eye-ball; it ends in the eye-

lid, by a broad expansion of muscular fibres, which finally terminate in a short flat tendon. It lies under the orbicularis palpebræ, is inserted into the whole length of the cartilage of the tarsus and raises and opens the upper eye-lid. And the division of the orbicularis oculi into two, by the older anatomists, was a consequence of their not knowing of the true levator palpebræ, and their not being able to describe any muscle by which the upper eye-lid could be raised, except the upper half of the orbicularis.

The occipito frontalis, but especially its occipital belly, raises the eye-brows ; the pointed slip of the same muscle pulls them downwards ; the corrugator pulls them directly inwards, and knits the brows ; the levator palpebræ opens the eye-lid and the orbicularis oculi closes the eye. Whether certain fibres from the platysma-myoides, (a thin flat muscle which mounts from the neck over the cheek,) may not pull down the lower eye-lid, or whether some straggling fibres, arising from the zygoma, may not have the appearance of a depressor of the lower eye-lid, it is not necessary to determine, since there is no regularly appointed muscle, and the lower eye-lid is almost immoveable, at least in man.

MUSCLES OF THE NOSE AND MOUTH.

V. *LEVATOR LABII SUPERIORIS* and *ALÆ NASI*. Cowper describes the levator labii superioris as an irregular production of the frontalis, extending along the nostrils. But it is a neat and delicate muscle, which arises, by a small double tendon, from the nasal process of the upper jaw-bone, close by the tendon of the orbicularis oculi. It is one little fasciculus of muscular fibres above ; but as it approaches the nose, it spreads out broader, dividing into two small fasciculi, one of which is implanted into the wing or cartilage of the nose, and the other passing the angle of the nose, goes to the upper lip : thus it is pyramidal with its base downwards, and was named *pyramidalis* by Casserius, Winslow, and others. It is called by Cowper *dilator alæ nasi* : it raises the upper lip, and spreads the nostrils wide, as is observed in a paroxysm of rage, or in asthmatics.

VI. The *LEVATOR LABII SUPERIORIS PROPRIUS* is distinguished by the name of levator, proprius, because there are two others ; one belonging to the angle of the mouth, and consequently to both lips ; and one common to the lip and nostril.

The levator proprius is often named *musculus incisivus*, because it arises from the upper jaw, just above the incisores, or cutting teeth, and consequently just under the edge of the

orbit; it is broad at its origin; it lies flat and runs downwards, and obliquely inwards, to the middle of the lip till it meets its fellow just in the *filtrum*.* It pulls the upper lip and the septum of the nose directly upwards. It generally receives a slip from the *orbicularis oculi*.

VII. The *LEVATOR ANGULI ORIS*, is called also *LEVATOR COMMUNIS LABIORUM*, because it operates equally on both lips. It is named *CANINIS*; for as the last named muscle rises from the upper jaw-bone above the incisores or cutting teeth, this arises above the canini or dog-teeth, or above the first grinder, by a very short double tendon. The exact place of its origin is half way betwixt the grinder and the infra orbitary hole: it is mixed with the *orbicularis oris*, at the corner of the mouth, so that it raises the angle of the mouth upwards.

VIII. The *ZYGOMATICUS MAJOR* has nearly the same direction and use with this one: for it arises from the cheek-bone near the zygomatic suture; runs downwards and inwards to the corner of the mouth; is a long and slender muscle, which ends by mixing its fibres with the *orbicularis oris* and the depressor of the lip.

IX. The *ZYGOMATICUS MINOR* arises a little higher upon the cheek-bone, but nearer the nose; it is much slenderer than the last, and is often wanting. In negroes we frequently find three zygomatic muscles.

It is the zygomatic muscle that marks the face with that line which extends from the cheek-bone to the corner of the mouth, and which is so strong in many. The zygomatic muscles pull the angles of the mouth upwards as in laughter; or one of them distorts the mouth, whence the zygomatic muscle has got the name of *distortor oris*: the strong action of the muscle is particularly seen in laughter, rage, grinning.

X. *BUCCINATOR*. The buccinator was long thought to be a muscle of the lower jaw, arising from the upper alveoli, and inserted into the lower alveoli to pull the jaw upwards; but its origin and insertion, and the direction of its fibres, are quite the reverse of this. For this large flat muscle, which forms, in a manner, the walls of the cheek, arises chiefly from the coronoid process of the lower jaw-bone and partly also from the end of the alveoli or socket process of the upper jaw, close by the pterygoid process of the sphenoid bone; it arises also from the upper jaw; it goes forwards with direct fibres to be implanted into the corner of the mouth; it is thin and flat, and forms the walls of the cheek; it is perforated in the middle of the cheek by the duct of the parotid gland. Albinus

*The *filtrum* is the superficial gutter along the upper lip from the partition of the nose to the tip of the lip.

describes two irregular sets of fibres besides mentioning those which are running directly to the angle of the mouth : 1. One narrow slip which runs in a semi-circular direction and joins the inner surface of the upper lip. 2. Another considerable slip which runs much in the direction of the orbicularis towards the middle of the lip, this he calls the appendix of the buccinator. These are its principal uses ; that it flattens the cheek, and so assists in swallowing liquids ; that it turns, or helps to turn, the morsel in the mouth while chewing, and prevents its getting without the line of the teeth : in blowing wind instruments, it both receives and expels the wind : it dilates like a bag, so as to receive the wind in the cheeks ; and it contracts upon the wind so as to expel the wind, and to swell the note : In blowing the strong wind instruments, we cannot blow from the lungs, for it stresses the breathing, but reserve the air in the mouth, which we keep continually full ; and from this it is named, from blowing the trumpet, the **BUCCINATOR**.

XI. DEPRESSOR ANGULI ORIS.—The depressor anguli oris is a neat small triangular muscle, and is indeed very commonly named **MUSCULUS TRIANGULARIS LABIORUM**, from its shape. The base of the triangle is at the line of the lower jaw, where the muscle rises with a flat fleshy head about an inch in breadth. It grows smaller gradually as it rises towards the corner of the mouth, where it is implanted, small almost in a point, and directly opposite to the zygomatic and levator muscles ; and as the zygomatic muscle makes a line from the cheek down to the angle of the mouth, this makes a line from the chin up to the corner of the mouth. It is chiefly active in expressing the passions, and gives form to the chin and mouth. In cheerful motions, as laughter, smiling, &c. the zygomatics and levators pull the angles of the mouth upwards. In fear, hatred, revenge, contempt, and the angry passions, the triangulares, pull the corners of the mouth downwards ; and at the place where these meet, there is formed a sort of rising at the angle of the mouth ; for a great many tendons are crowded into this one point : the zygomatic, levator, depressor, and orbicularis oris muscles meeting and crossing each other at this place.

XII. The DEPRESSOR LABII INFERIORIS is a small muscle, the discovery which Cowper claims for himself. It is a small muscle, lying on each side of the chin, which, with its fellow, resembles very much the levators of the upper lip. The depressor labii inferioris arises on each side of the chin, from the lower jaw-bone, under the line of the triangular muscle. It grows obliquely upwards and inwards, till it meets its fellow in the middle of the lip ; and where the muscles of the opposite side meet, there is a little filtrum or furrow on the lower lip, as

on the upper one. It mixes its fibres with the orbicularis, and its use is to pull the lip downwards ; each muscle is of a square form, and thence has been often named *QUADRATUS GENÆ*, the square muscle of the chin.

XIII. The *ORBICULARIS ORIS*, or muscle round the mouth, is often named *CONTRACTOR ORIS*, *SPHINCTER*, or *OSculator*. It is very regular ; it is an inch in breadth, and constitutes the thickness of the lips : it lies in the red part of the lips, and is of a circular form, surrounding the mouth after the same manner that the orbicularis oculi encircles the eye. We see a degree of crossing in the fibres at the angles of the mouth, whence it has been considered by many not as a circular muscle, but as one consisting of two semi-circular muscles, the *SEMI ORBICULARIS SUPERIOR*, and *SEMI ORBICULARIS INFERIOR*. Its fixed points are the two angles of the mouth ; at that swelling which is formed by the union of the zygomatic, triangular, and other muscles, part of it takes origin from the alveolar process of the canine teeth. The chief use of this muscle is to contract the mouth and antagonize the other muscles which I have just described. Often a small slip runs up from the middle of the upper lip, to the tip of the nose ; it is the *NASALIS LABII SUPERIORIS* of Albinus ; it lies exactly in the furrow of the *filtrum*, and is occasionally a levator of the upper lip, or a depressor of the tip of the nose.

These muscles of the nose and lips are not useful merely in expressing the passions ; that is but a secondary and accidental use, while their great office is to perform those continual movements, which breathing, speaking, chewing, swallowing, require. There are muscles for opening the mouth in various directions, which are all antagonized by this one, the orbicularis oris. The levator labii superioris, and the depressor labii inferioris, separate the lips and open the mouth. The levator anguli oris, along with the zygomatic muscles, raises the cheek, and dilates the corners of the mouth. The buccinator pulls the corner of the mouth directly backwards, opening the mouth. The angularis oris also dilates the mouth, pulls the angles of the mouth downwards and backwards, and forms it into a circle, if the others act at the same time ; but the orbicularis oris is the largest and strongest, (formed as it were, by the fibres of all these taking a new direction, and turning round the lips,) shuts the mouth and antagonizes them all, and from an opening as wide as the mouth can require, shuts the mouth at pleasure, so closely, as to retain the very breath against all the force of the lungs. It is the true antagonist of all the other muscles, and they and the orbicularis mutually re-act on each other, in alternately opening and closing the mouth. This phenome-

non of the orbicularis muscle, dilating to such a wideness and in an instant closing the mouth again, with such perfect accuracy, as to retain the breath, puts to naught all the vain calculations about the contraction of muscles, as that they can contract no more than one third of their length; for here is an infinite contraction, such as no process can measure. It is a paralysis of these muscles that so often occasions a hideous distortion of the face; for when the one side of the body falls into palsy, the muscles of one cheek cease to act; the muscles of the other cheek continue to act with their usual degree of power. This contraction of the muscles of one cheek excites also the orbicularis oris to act, and so the mouth is pursed up, and the lips and angles of the mouth are drawn towards one side.

There are some smaller muscles, which lying under these, could not be described without danger of confusion; as—

XVI. The *DEPRESSOR LABII SUPERIORIS* and *ALÆ NASI*, which is very small, and lies concealed under the other muscles. It rises from the gum or socket of the fore teeth, and thence is named, by Winslow, *incisivus medius*. It goes into the root of the nostril, and pulls it, and, of course, the upper lip down, and is named, by Albinus, *depressor alæ nasi*.

XV. The *CONSTRUCTOR NASI*, or compressor of the nose is a small scattered bundle of muscular fibres, which crosses the wings, and goes to the very point of the nose; for one arises from the wing of the nose on each side, and meets its fellow in the middle ridge, where both are fixed into the middle cartilage, or into the lower point of the *NASIL* bones, meeting with the peak of the frontal muscle, or its scattered fibres. But this muscle is so difficultly found, that when Cowper saw it distinctly marked in Bidloe's 12th table, he considered it as a fiction, having sought for it very carefully, but in vain.

And XVI. The *LEVATOR MENTI*, which arises from the lower jaw, at the root of the cutting tooth, has been named *INCISIVUS INFERIOR*. It is inserted into the skin, on the very centre of the chin: by its contraction it draws the centre of the chin into a dimple; and from its moving the under lip at the same time, it is named *LEVATOR LABII INFERIORIS*.

MUSCLES OF THE EXTERNAL EAR.

THOUGH perhaps not one of ten thousand has the power of moving the outward ear, yet there are many thin and scattered fibres of muscles about the root of the cartilage of the ear, to which we cannot refuse the name and distinction of muscles;

and which serve, indeed, to indicate, that nature had intended a degree of motion, which, perhaps by the manner of covering the heads of children, we may have lost. But in a few, these fasciculi of fibres, have not the form only, but the uses of muscles. The celebrated Mr. Mery, was wont, when lecturing on this subject, to amuse his pupils, saying, pleasantly, "that in one thing, he surely belonged to the long ear'd tribe;" upon which he moved his ears very rapidly backwards and forwards.*

XVII. SUPERIOR AURIS is named attollens because it lifts the ear upwards: it is a very thin, flat expansion, which can hardly be distinguished from the fascia of the temporal muscle, upon which it lies; it arises broad and circular, from the expanded tendon of the occipito frontalis, and is inserted into the back part of the antihelix.

XVIII. ANTERIOR AURIS is a very delicate, thin, and narrow expansion, arising about the zygoma, or rather from the fascia, with which the zygoma is covered; it is inserted by a tendon into that eminence of the helix which divides the concha.

XIX. The POSTERIOR AURIS is also a small muscle, very delicate and thin; but the anterior rises in one small and narrow slip only, while this, the posterior, rises commonly, in three narrow and distinct slips, from about the place of the mastoid process;† whence it is often named **TRICEPS AURIS**. These fibres are often described as two distinct muscles, retrahentes: it goes directly forwards to be inserted into the back part of the concha, opposite the septum that divides the concha, by two slips.

But there are still other muscles enumerated, which are not for moving the outward ear upon the head, but for moving, or rather giving tension to the cartilage of the outward ear.—Those fibres, are merely muscular membranes, which have none of the marks nor offices of true muscles; they have seldom fleshy fibres, and the parts upon which they lie are fixed. Heister denies them the title of muscles, and calls them muscular membranes only.

The ring and other bendings of the outward ear are called helix and antihelix, tragus and antitragus; and this determines the names of these ambiguous fibres, which are sometimes found lying upon these circles of the outward cartilage, just under the skin.

XX. The MUSCULUS HELICIS MAJOR lies upon the upper, or sharp point of the helix or outward ring; rising from the

* Vide Palfin, who was his pupil. The celebrated Albinus could move his ears.

† *Fibræ carnae transversæ, a nobis descriptæ. Valsalva.*

upper and acute point of the helix, and inserted into the same cartilage a little above the tragus.

XXI. *HELICIS MINOR* rises lower than the former, upon the forepart of the helix, and runs across the notch which is in that part of the helix that projects into the concha, the muscle having its origin above the notch, and its insertion below it.

XXII. The *TRAGICUS* lying upon the concha, and stretching to the tragus ; takes its origin from the middle of the concha to the root of the tragus, and is inserted into the tip of the tragus.

XXIII. The *ANTITRAGICUS* lies on the antitragus, running up from this cartilage to be inserted into the edge of the concha, at the notch on the termination of the helix.

XXIV. And, lastly, There is the *TRANSVERSUS AURIS* of Albinus, which runs in scattered fibres on the back part of the ear from the prominent part of the concha to the outer side of the antihelix.

MUSCLES OF THE EYE-BALL.

The eye-ball is entirely surrounded by muscles, which turn it in all directions. There is one muscle on either side, one above and one below ; these arise from the very bottom of the socket, spread out upon the ball of the eye, and are implanted into its forepart, where the expansions of their colourless tendons form what is called the white of the eye. Now these four muscles, coming in a straight course from the optic foramen to the anterior part of the eye-ball, are called the recti, or straight muscles : for their pulling is from the bottom of the socket. But there are two other muscles which are named the oblique muscles, because they pull from the edges of the socket, and turn the eye obliquely ; for they go in a direction exactly opposite to the recti. The recti come directly forwards, from the bottom of the orbit ; these go obliquely backwards, from the edge of the orbit ; one rises from the lower edge of the socket, and goes backwards under the eye-ball ; the other rises, indeed, along with the recti, in the bottom of the socket, but it has a cartilaginous pulley on the very edge of the socket, at its upper part ; and its small round tendon first runs through this pulley, and then turns down upon the eye, and goes backwards ; so that the straight muscles press down the eye-ball deep into the socket, while the oblique muscles bring the eye-ball forwards, pulling it outwards from the socket.

The truest description of the recti is as of one muscle, since their only variety is that difference of place, which is expres-

sed by the name of each. They all agree in these chief circumstances, that they arise by flat, but small tendons, round the margin of the optic hole, arising from the circle of that hole, or rather from the periosteum there; and there being one above, one below, and one on either side, they completely surround the optic nerve, and adhere to it. They are neat and delicate muscles, which gradually expand each into a fleshy belly, which surrounds and covers the middle of the ball of the eye. They still go on expanding, till they at last terminate, each in a broad, flat, and very white tendon, which covers all the forepart of the eye, up to the circle of the lucid cornea or window; and their white and shining tendons form that enamelled-like part, which lies without the coloured circle, and which is named the white of the eye, or the *TUNICA ALBUGINEA*, as if it were absolutely a distinct coat.

Now, the only difference in these straight muscles is in respect to length; for the optic nerve enters the eye, not regularly in the centre, but a little towards the inner side, so that the *rectus internus*, or muscle nearest the nose, is a little shorter. The *rectus externus*, or muscle nearest to the temple, is a little longer: but the *rectus superior* and the *rectus inferior* are of equal length. The uses of these muscles are exceedingly plain.

XXV. The *RECTUS SUPERIOR*, lifting the eye directly upwards is named the *MUSCULUS ATTOLLENS*, the *LEVATOR OCULI* or *SUPERBUS*, as expressive of haughtiness and pride.

XXVI. And the *RECTUS INFERIOR*, which is directly opposite to it, is named *DEPRIMENS OCULI* or *HUMILIS*, as expressing modesty and submission.

XXVII. The *RECTUS INTERNUS* is called *ADDUCENS*, as carrying the eye towards the nose, or *BIBITORIUS*, because it directs the eye to the cup.

And XXVIII. the *RECTUS EXTERNUS*, the outer straight muscle, as it turns the eye from the nose, is named *ABDUCTOR OCULI*, or *INDIGNABUNDUS*, expressing anger or scorn. Such is the effect of these muscles, that when they act in succession, they roll the eye; but if they act all at once, the power of each is balanced by the action of its opposite muscle, and the eye is immoveably fixed. So that sometimes in our operations, when the couching needle approaches the eye fear comes upon the patient, and the eye is fixed by a convulsive action, more firmly than it could be by the instruments, or by the fingers; so that the *speculum oculi* is after such an accident of no use. The eye continues fixed during all the operation, but it is fixed in a most dangerous way by a power which we cannot control, and which sometimes, when our operation is for extracting one of the humours only, squeezes out the whole.

XXIX. The **OBLIQUUS SUPERIOR** arises along with the recti in the bottom of the eye, above and towards the inner side, directing its long tendon towards the inner angle of the eye; and there it passes its tendon through that pulley, whose hollow I have marked in describing the os frontis, as under the superciliary ridge, and near to the inner corner of the eye. It arises by a small tendon like one of the recti; it goes over the upper part of the eye-ball, a long and slender muscle, whence it is often named **LONGISSIMUS OCULI**, the longest muscle of the eye. It forms a small smooth round tendon, which passes through the ring of the cartilaginous pulley, which is in the margin of the socket. The pulley is above the eye and projects farther than the most prominent part of the eye-ball, so that the tendon returns at an acute angle, and bends downwards before it can touch the eye-ball. And it not only returns backwards in a direction opposite to the recti muscles, but it slips flat under the body of the rectus superior, and is spread out under it upon the middle or behind the middle of the eye, viz. about half way betwixt the insertion of the rectus, and the entrance of the optic nerve.

XXX. The **OBLIQUUS INFERIOR** is, with equal propriety, named the **musculus brevissimus oculi**. It is directly opposite to the obliquus superior, in form, place, office, &c.; for it arises from the orbitary process of the superior maxillary bone, near its union with the os unguis: it is short, flat, and broad, with a strong fleshy belly: it goes obliquely backwards and outwards, lying under the ball of the eye; and it is inserted broad and flat into the ball, exactly opposite to the insertion of the obliquus superior muscle.

These two muscles roll the eye, whence they are named **musculi circumagentes**, or **amatorii**. But they have still another important office, viz. supporting the eye-ball, for the operation of its straight muscles; for when the obliqui act, they pull the eye forwards, the straight muscles resist, and the insertion of the oblique muscles at the middle of the eye-ball becomes, as it were a fixed point, a centre or axis round which the eye-ball turns under the operation of the recti muscles. The conjoined effect of the oblique muscles is to bring the eye-ball forwards from the socket, as in straining the eye to see at some distant point. The particular effect of the upper oblique muscle is not to bring the eye forward, but to roll the eye so as to turn the pupil downwards, and towards the nose. And the particular effect of the lower oblique muscle is to reverse this action, to turn the eye again upon its axis, and to direct the pupil upwards and outwards; but the successive actions of all these muscles move the eye in circles, with

gradations so exquisitely small, and with such curious combinations as cannot be explained by words.

CHAP. II.

MUSCLES OF THE LOWER JAW, THROAT, AND TONGUE.

MUSCLES OF THE LOWER JAW.

THE lower jaw requires muscles of great power to grind the food ; and accordingly it is pulled upwards by the strong temporal, masseter, and pterygoid muscles : but in moving downwards, the jaw almost falls by its own weight, and having little resistance to overcome, any regular appointment of muscles for pulling down the jaw is so little needed, that it is pulled 'downwards by muscles of such ambiguous office, that they are equally employed in raising the throat, or pulling down the jaw, so that we hardly can determine to which they belong ; for the chief muscles of the throat, coming from the lower jaw, must, when the jaw is fixed, pull up the throat, or when the throat is fixed, depress the jaw.

XXXI. The **TEMPORAL MUSCLE** is the great muscle of the jaw. It arises from all the flat side of the parietal bone, and from the sphenoid, temporal, and frontal bones, in that hollow behind the eye, where they meet to form the squamous suture. It arises also from the inner surface of that strong tendinous membrane which is extended from the jugum to the semi-circular ridge of the parietal bone. The fibres are bundled together and pressed into a small compass, so that they may pass under the jugum : there they take a new hold upon the inner surface of the jugum : the muscle is of course pyramidal, its rays converging towards the jugum ; its muscular fibres are intermixed with strong tendinous ones ; it is particularly tendinous, where it passes under the jugum ; and it has both strength and protection from that tendinous plate which covers it in the temple. Its insertion is into the coronoid process of the lower jaw-bone ; not merely into the tip of the horn, but embracing it all round, and down the whole length of the process, so as to take the firmest hold.

XXXII. The **MASSETER** is a short, thick, and fleshy muscle, which gives the rounding of the cheek at its back part. It arises from the upper jaw-bone, at the back of the antrum, and

under the cheek-bone, and from the lower edge of the zygoma. It lies upon the outside of the coronoid process, covering the branch of the lower jaw quite down to its angle. It is particularly strong, has many massy bundles of flesh, interspersed with tendinous strings; the parotid gland lies on its upper part, and the duct of the gland (as it crosses the cheek) lies over the muscle. The jaw is very firmly pulled up by these two, which are its most powerful muscles: and when we bite, we can feel the temporal muscle swelling on the flat part of the temple, and this the masseter upon the back part of the cheek.

XXXIII. XXXIV. The two PTERYGOID MUSCLES (of which there are four in all, two on either side,) are named from their origin in the pterygoid processes of the sphenoid bone. The PTERYGOIDEUS INTERNUS is that one which rises from the internal or flatter pterygoid process, and which goes downwards and outwards to the angle of the jaw on its inside: it fills up the fossa pterygoidea. The PTERYGOIDEUS EXTERNUS arises from the external pterygoid process, and goes not downwards, but almost directly outwards, and is implanted high in the jaw-bone, just under its neck, and connected with its capsular ligament. Now the pterygoideus internus descending to be fixed to the angle of the jaw, is longer and bigger, and is named PTERYGOIDEUS MAJOR. The external one going directly across, and rather backwards, has less space to traverse, is shorter, and is named PTERYGOIDEUS MINOR.

The jaw is moved chiefly by these muscles; the temporalis acting upon the coronoid process like a lever, the masseter acting upon the angle, and before it, and the pterygoideus internus balancing it within, like an internal masseter fixed on the inside of the angle. All these pull strongly upwards for biting, holding, and tearing with the teeth; and the external or lesser pterygoid muscle going from within outwards, pulls the jaw from side to side, and performs the motion of grinding.

MUSCLES OF THE THROAT AND TONGUE.

The MUSCLES of the THROAT and TONGUE cannot be understood without a previous acquaintance with certain cartilages and bones, which form the basis of the throat and tongue, and the centre of those motions which we have next to describe.

The os HYOIDES is a small bone resembling in shape at least the lower jaw-bone. It has a middle thicker part, named its basis, which is easily felt outwardly; it corresponds in place with the chin, and during life it is distinguished about an inch

below the chin, the uppermost of the hard points, which are felt in the forepart of the throat. Next, it has two long horn-like processes, which go backwards along the sides of the throat, called the cornua, or horns of the os hyoides, and which are tied by a long ligament to the styloid process of the temporal bone. And, lastly, it has small cartilaginous pieces or joinings, by which the horns are united to the basis; and often in the adult this joining is converted into bone. At this point, where the two horns go backwards, like the legs of the letter U, there are commonly, at the gristly part of the os hyoides, two small perpendicular processes which stand up from the joining of the horns to the body, and these are named appendices of the os hyoides or the lesser cornua.

Now, this os hyoides forms by its basis the root of the tongue, thence it is often named the bone of the tongue. It forms at the same time a part of the larynx, which is the collection of cartilages forming the top of the trachea, or windpipe; and it carries upon it that cartilage named epiglottis, which, like a valve prevents any thing getting down into the windpipe. Its horns extend along the sides of the throat, keeping the openings of the windpipe and gullet extended, as we would keep a bag extended by two fingers. The chief muscles of the tongue and of the windpipe arise from its body; the chief muscles of the gullet arise from its horns, and especially from their points; it receives the chief muscles which either raise or depress the throat; and it is the point d'appui, or fulcrum for all the muscles of the throat and tongue, and the centre of all their motions. It is the centre of the motions of the tongue, for it is the origin of these muscles which compose chiefly the bulk of the tongue; of the motions of the trachea or windpipe, for it forms at once the top of the windpipe, and the root of the tongue, and joins them together; of the motions of the pharynx or gullet, for its horns surround the upper part of the gullet, and join it to the windpipe; and it forms the centre for all the motions of the throat in general: for muscles come down from the chin to the os hyoides, to move the whole throat upwards; others come up from the sternum, to move the throat downwards; others come obliquely from the coracoid process of the scapula, to move the throat backwards, while the os hyoides still continues the centre of all these motions.

The TRACHEA or WINDPIPE, is that tube which conveys the air to the lungs; and the larynx is the head or figured part of that tube which is formed like a flute for the modulation of the voice, and consists of cartilages, that it may stand firm and uncompressed, either by the passage of the food or by the weight of the outward air; and that it might resist the contraction of

the surrounding parts, serving as a fulcrum for them in the motions of the jaw, tongue, and gullet. Its cartilages are first, the scutiform or thyroid cartilage, which is named from its resemblance to a shield, or rather it is like the flood-gates, or folding-doors of a canal, the meeting of the two sides being in the middle line of the throat. This prominent line of the thyroid cartilage is easily felt in the middle of the throat, is about an inch in length, and makes that tumour which is called the *pomum Adami*. The flat sides of the thyroid cartilage form the sides of the flute-part of the trachea. And there are two long horns at its two upper corners, which rise like hooks above the line of the cartilage, and are joined to the horns of the *os hyoides*, and two similar but shorter hooks below, by which it embraces the cricoid cartilage.

The CRICOID CARTILAGE is next to the thyroid, and below it; it is named from its resemblance to a ring: It is indeed like a ring or hoop, but it is not a hoop equally deep in all its parts, it is shallow before, where it ekes out the length of the thyroid cartilage, and is deeper behind, where it forms the back of this flute-like top of the trachea; it is the top ring of the trachea, and the lower ring of the larynx or flute-part of the wind-pipe. And upon its back, or deeper part, are seated those two small cartilages, which, with their ligaments, form the opening of the breath.

The ARYTENOID CARTILAGES are two small triangular bodies seated within the protection of the thyroid cartilage. They are foolishly described with cornua ridges and surfaces, when they are so small that nothing further can be observed of their forms, than that they are somewhat conical; that the base or broad part of each sits down upon the upper edge of the cricoid cartilage at its back; that the point of each stands directly upwards, and is a very little crooked, or hook-like; that standing, as they do, a little apart from each other, they form together an opening something like the spout of a ewer, or strouped basin, whence their names. And these cartilages being covered with the common membrane of the throat, which is thick, and full of mucous glands, the opening gets a regular appearance with rounded lips. From these cartilages to the back part of the thyroid cartilages, ligaments are extended; over these ligaments the lining membrane of the larynx is laid, and betwixt the arytoid ligaments is formed the chink or rima glottidis; viz. the opening of the wind-pipe. The voice is, in a considerable degree, formed by the motion of these cartilages and their ligaments; and the action of the muscles of the arytoid cartilages are so exquisitely minute, that for every changing of the note (and there are some thousand

gradations in the compass of the voice) they move in a proportioned degree.

The **EPIGLOTTIS** is a fifth cartilage of the trachea, belonging to it both by connexion and by office. It is a broad triangular cartilage, not so hard as the others, very elastic, and so exactly like an artichoke leaf, that no other figure can represent it so well. Its office is to defend the opening of the glottis. It is fixed at once to the os hyoides, to the thyroid cartilage, and to the root of the tongue, and it hangs obliquely backwards over the opening of the rima, or chink of the glottis; it is suspended by little peaks of the membrane, which we call ligaments of the glottis, and it is said to be raised or depressed by muscles, which yet are not very fairly described. But the rolling of the morsel which is swallowed, and the motion of the tongue, are sufficient to lay it flat over the rima, so that it is a perfect guard upon the wind-pipe.

Then this is the constitution of the larynx. It is of hard cartilages to resist compression, and of a flute form at its opening, to regulate the voice. The **THYROID** cartilage is the great one, the chief defence before, and which has edges slanting far backwards, to defend the opening of the larynx. The **CRICOID** cartilage, which forms the upper ring of the trachea, supports the arytenoid cartilages, and by its deepness behind, raises them so that the opening of the glottis is behind the middle of the great thyroid cartilage, and in the deepest part of it, well defended by its projecting wings. The **ARYTENOID** cartilages form the rima glottidis, the chink by which we breathe; which as it is narrower or wider, modulates and tunes the voice; the opening of which is so exquisitely moved by its muscles in singing, widening or contracting in most delicate degrees, and which is so spasmodically shut by the same muscles when it is touched by a drop of water, or by a crumb of bread; but the valve of the glottis, the **EPIGLOTTIS** standing over it, flaps down like the key of a wind instrument, so that the rareness of such accidents is wonderful, when we consider that the least attempt to draw the breath, while we are swallowing, will produce the accident.

The muscles which move the tongue and throat must be far too complicated to be explained at all, without some previous knowledge of these parts: and still, I fear, not easily to be explained with every help of regularity and order.

MUSCLES OF THE THROAT.

By this arrangement, I mean to include under one class, all those muscles which move the os hyoides, or the larynx, and

through these, as central points, move the jaws, gullet, and tongue, and which, though they are inserted into the larynx, have more relation to swallowing, or the motions of the gullet, than to breathing, or to the motions of the wind-pipe.

The muscles which pull the throat down are these :

XXXIV. The STERNO-HYOIDEUS, which passes from the sternum to the os hyoides ; a flat, broad, ribband-like muscle, arises from the upper piece of the sternum, rather within the breast, and partly also from the clavicle and cartilage of the first rib, goes flat and smooth along the forepart of the throat, mounts nearly of the same breadth to the os hyoides, and is implanted into its basis, or that part (which in resembling the os hyoides to the jaw) we should compare with the chin.

XXXV. The STERNO-THYROIDEUS, which passes in like manner from the sternum to the thyroid cartilage, is like the last, a flat, smooth, ribband-like muscle, rather thicker and more fleshy, but very uniform in its thickness. As the thyroid cartilage is below the os hyoides, the sterno-thyroid muscle must lie under the sterno-hyoideus muscle. It arises under the sterno-hyoideus muscle from the sternum and cartilage of the rib, and is implanted into the rough line of the lower edge of the thyroid cartilage, and a little to one side, but not so much as is represented in Cowper's drawings. It immediately covers the thyroid gland, and the operation of bronchotomy is sometimes performed by piercing the wind-pipe betwixt these two muscles.

XXXVI. The OMO-HYOIDEUS, which was once named CORACO-HYOIDEUS, being thought to arise from the coracoid process, is a muscle of great length, and very slender ; reaches from the shoulder to the os hyoides ; it is like these last mentioned, a long, flat, strap-like muscle, as flat and as fleshy, but not so broad as either of the former. It lies along the side of the neck ; is pinched in a little in the middle, where it is divided by a tendinous cross line, which separates the fleshy belly into two heads, whence it has frequently the name of digastricus inferior. It arises from the upper edge of the scapula, near its notch, and is implanted into the side of the os hyoides, where the horn goes off from the body of the bone.

These three muscles pull down the throat. The sterno-hyoides, and sterno-thyroideus pull it directly downwards : one of the omo-hyoidei acting, pulls it to one side ; but if both act, they assist in pulling directly down, and brace the trachea at the same time a little down to the back.

The muscles which move the throat upward are :

XXXVII. The MYLO-HYOIDEUS, a flat and broad muscle, which arises from the whole semi-circle of the lower jaw, (*i. e.*)

from the backmost grinders to the point of the chin. It rises from the inner surface of the jaw-bone, goes down to the basis of the os hyoides, proceeds with very regular, straight, distinct, and orderly fibres, from the jaw to the os hyoides, is plainly divided in the middle from the symphysis of the jaw to the middle of the os hyoides, by a middle tendinous and white line. And though Cowper denies the authority of Vesalius, who divides it thus, it is plainly two distinct muscles, one belonging to either side.

XXXVIII. The GENIO-HYOIDEUS is a small neat pair of muscles arising from the chin at a rough point, which is easily distinguished within the circle of the jaw. The mylo-hyoideus is named from the whole jaw. The genio-hyoideus is named from the chin, arising from a small tubercle behind the chin; its beginning is exceedingly narrow: as it proceeds downwards, it grows flat and broad; it is implanted into the basis of the os hyoides, by a broad edge, and is a beautiful and radiated muscle. The sub maxillary gland lies flat betwixt this muscle and the last, and in the middle the sub-maxillary duct pierces the membrane of the mouth, to open under the root of the tongue. The two muscles move the os hyoideus forwards and upwards when the jaw is fixed; but when the os hyoideus is fixed by the muscles coming from the sternum, these muscles of the os hyoides pull down the jaw.

XXXIX. The STYLO-HYOIDEUS is one of three beautiful and slender muscles, which come from round the styloid process, which all begin and end with slender tendons, and with small fleshy bellies; and one going to the pharynx or gullet, another to the os hyoides, and a third to the tongue, they coincide in one common action of drawing back the tongue, and pulling the throat upwards.

This one, the stylo-hyoideus, arises from about the middle of the styloid process, and going obliquely downwards and forwards, is fixed into the side of the os hyoides, where the basis and horn are joined. Above its insertion, its fibres are split, so as to make a neat small loop, through which the tendon of the digastric muscle runs. This stylo-hyoideus is sometimes accompanied with another small fleshy muscle like it, and of the same name, which was first, perhaps, observed by Cowper, and has been named by Innis, STYLO-HYOIDEUS ALTER; but it is not regular, nor has it ever been acknowledged as a distinct muscle.

XL. The DIGASTRICUS OR BIVENTER MAXILLÆ INFERIORIS muscle, is named from its having two bellies. One belly arises from a rugged notch along the root of the mastoid process, where the flesh is thick and strong; going obliquely forwards

and downwards, it forms a long slender tendon, which passes by the side of the os hyoides ; and as it passes, it first slips through the loop or noose of the stylo-hyoideus, and then is fixed by a tendinous bridle to the side of the os hyoides ; and then turning upwards towards the chin, it ends in a second fleshy belly, which, like the first, is flat and of a pyramidal shape, lying above the mylo-hyoideus.

Though this muscle is often called *biventer maxillæ inferioris*, as belonging to the lower jaw, perhaps it does more regularly belong to the throat. No doubt, when the os hyoideus is fixed by its own muscles, from the shoulder and sternum, the digastricus must act on the jaw ; an office which we cannot doubt, since we often feel it taking a sudden spasm, pulling down the chin with severe pain, and distortion of the neck. But its chief office is raising the os hyoides ; for when the jaw is fixed as in swallowing, the os hyoides pulls up the throat ; and this is the true meaning of its passing through the noose of the stylo-hyoideus, and of its connexion with the side of the os hyoides. Then the digastric and stylo-hyoideus muscles pull the throat upwards and backwards.

The muscles which move the parts of the larynx upon each other are much smaller, and many of them very minute.

XLI. The *HYO-THYROIDEUS* goes down, fleshy and short, from the os hyoides to the thyroid cartilage. It arises from the lower border of the thyroid cartilage where the *sterno-thyroideus* terminates, and goes up along the side of the thyroid cartilage, like a continuation of the *sterno-thyroideus* muscle. It passes the upper border of the thyroid cartilage, and is fixed to the lower edge of the os hyoides, along both its base and part of its horn.

XLII. The *CRICO THYROIDEUS* is a very short muscle, passing from the upper edge of the cricoid to the lower margin of the thyroid cartilage, chiefly at its side, and partly attached to its lower horn, which comes down clasping the side of the *CRICOID* ring, so that it is broader above, and a little pointed below.

These two small muscles must have their use, and they bring the thyroid cartilage nearer to the os hyoides, and the cricoid nearer to the thyroid cartilage ; and by thus shortening the trachea, or compressing it slightly, they may perhaps affect the voice ; but the muscles on which the voice chiefly depends are those of the *RIMA GLOTTIDIS* ; for there are many small muscles which have their attachment to the arytenoid cartilages, and which by their operation on the thyro-arytenoid ligament govern the rima glottidis.

XLIII. The **MUSCULUS ARYTENOIDEUS TRANSVERSUS**, is that delicate muscle which contracts the glottis by drawing the arytenoid cartilages towards each other. It lies across, betwixt them at their back part; it arises from nearly the whole length of one arytenoid cartilage to go across, and be inserted into the same extent of the opposite one.

XLIV. **ARYTENOIDEUS OBLIQUUS** is one which crosses in a more oblique direction, arising at the root of each arytenoid cartilage, and going obliquely upwards to the point of the opposite one. These two muscles draw the arytenoid cartilages together, and close the **RIMA**: frequently we find only one oblique muscle.

XLV. The **CRICO-ARYTENOIDEUS POSTICUS**, is a small pyramidal muscle which arises broader from the back part of the cricoid cartilage, where the ring is broad and deep; and going directly upwards, is implanted with a narrow point, into the back of the arytenoid cartilage. This pair of muscles pulls the arytenoid cartilages directly backwards, and lengthens the slit of the glottis: perhaps they assist the former, in closing it more neatly and in producing more delicate modulations of the voice.

XLVI. The **CRICO-ARYTENOIDEUS OBLIQUUS** is one which comes from the sides of the cricoid cartilage, where it lies under the wing of the thyroid, and being implanted into the sides of the arytenoid cartilages, near their roots, must pull these cartilages asunder, and (as the origin in the cricoid lies rather before their insertion in their arytenoid cartilages) it must also slacken the lips of the slit; for the lips of the slit are formed by two cords, which go within the covering membrane, from the tip of each cartilage, to the back of the thyroid cartilage, and the crico-arytenoideus posticus must stretch these cords, and the crico-arytenoideus lateralis must relax them.

XLVII. The **THYREO ARYTENOIDEUS** is a muscle very like the last one, and assists it. It arises not from the cricoid cartilage, but from the back surface of the wing of the thyroid, from the hollow of its wing, or where it covers the cricoid; is implanted into the forepart of the arytenoid cartilage, and by pulling the cartilage forward and sideways, directly slackens the ligaments, and widens the glottis.*

* There is in Albinus, a second set of fibres, which he calls thyreo arytenoideus alter, arising from the inner and upper part of the thyroid cartilage and inserted into the arytenoid cartilage just above the insertion of the crico-arytenoideus obliquus; this muscle must have much the same action as the other.

There is another muscle which has been omitted in the text, thyreo epiglottideus. It is composed of a number of fibres, which run from the concavity of the thyroid cartilage to the side of the epiglottis; it has been divided by Albinus into major and minor, but this we cannot expect to find always, as it is only in very muscular bodies that we see fibres running from the thyroid cartilage to the epig-

These are all the muscles which belong to the larynx; and in our arrangement the muscles of the PALATE and PHARYNX come next in order.

When a morsel is to be thrown down into the œsophagus, or tube which leads to the stomach, the VELUM PALATI, or curtain of the palate, is drawn upwards; the opening of the throat is dilated; the morsel is received; then the curtain of the palate falls down again. The arch of the throat is contracted, the bag of the pharynx is compressed by its own muscles; and the food is forced downwards into the stomach.

XLVIII. The AZYGOSUVULÆ.—The VELUM PENDULUM PALATI is that pendulous curtain which we see hanging in the back part of the mouth, in a line with the side circles of the throat and the uvula is a small pap, or point of flesh, in the centre of that curtain. The AZYGOS UVULÆ, or single muscle of the uvula, is a small slip of straight fibres, which goes directly down to the uvula in the centre of the curtain. It arises from the peak, or backmost sharp point of the palate bones, and pulls the uvula, or pap of the throat directly upwards, removing it out of the way of the morsel which is to pass.

XLIX. LEVATOR PALATI MOLIS arises from the point of the os petrosum, and from the EUSTACHIAN tube, and also from the sphenoid bone.* These parts hang over the roof of the velum, and are much higher than it; so this muscle descends to the velum, and spreads out in it; and its office is to pull up the velum, to remove it from being in the way of the morsel, which is about to pass, and to lay the curtain back to the same time, so as to be a valve for the nostrils, and for the mouth of the Eustachian tube, hindering the food or drink from entering into these passages.

L. The CIRCUMFLEXUS PALATI,† and the constrictor isthmi faucium, have a very different use. The circumflexus palati is named from its fibres passing over, or rather under the hook of the internal PTERYGOID process; the muscle arises along with the levator palati, (*i. e.*) from the sphenoid bone at its spinous process; and from the beginning of the Eustachian tube,

lottis. Along with this muscle may be classed the set of fibres which are seen sometimes running from the arytenoid cartilage to the epiglottis, and called aryteno-epiglottideus.

* From the Eustachian tube, it was named SALPINGO STAPHILINUS; from the sphenoid bone, SPHERO STAPHILINUS; from the pterygoid process, PTERYGO STAPHILINUS; from the petrous process it was named PETRO SALPINGO STAPHILINUS; as if there were no science but where there were hard names, and as if the chief mark of genius were enriching the hardest names with all possible combinations and contortions of them.

† This also, has got a tolerable assortment of hard names, as CIRCUMFLEXUS PALATI, TENSOR PALATI, PALATO SALPINGEUS STAPHILINUS, EXTERNUS, SPHERO-SALPINGO-STAPHILINUS, MUSCULUS TUBÆ, VIZ. EUSTACHIANÆ NONUS PTERYGO-STAPHILINUS of Cowper, &c.

it runs down along the tube, in the hollow betwixt the pterygoid processes; it then becomes tendinous, turns under the hook of the internal pterygoid process, and mounts again to the side of the velum. Now the levator and circumflexus arise from the same points; but the levator goes directly downwards into the velum and so is useful in lifting it up. The circumflexus goes round the hook, runs on it as on a pulley, turns upwards again, and so it pulls down the palate, and stretches it, and thence is very commonly named the *TENSOR PALATI MOLLIS*, or stretcher of the palate.*

LI. The *CONSTRUCTOR ISTHMI FAUCIUM* arises from the very root of the tongue on each side, goes round to the middle of the velum, and ends near the uvula.† This semi-circle forms that first arch which presents itself, upon looking into the mouth.

LII. The *PALATO-PHARYNGEUS*‡ again forms a second arch behind the first: for it begins in the middle of the soft palate, goes round the entry of the fauces, ends in the wing or edge of the thyroid cartilage; and as the first arched line (that formed by the constrictor,) belonged to the root of the tongue the second arched line belongs to the pharynx or gullet.§ The circumflexus palati makes the curtain of the palate tense, and pulls it downwards: the constrictor faucium helps to pull down the curtain, and raises the root of the tongue to meet it: the palato-pharyngeus farther contracts the arch of the fauces, which is almost shut upon the morsel now ready to be forced down into the stomach, by those muscles which compress the pharynx itself.

The *PHARYNX*, which is the opening of the gullet, that it may receive freely the morsel of food, is expanded into a large and capacious bag, which hangs from the basis of the skull, is chiefly attached to the occipital bone, the pterygoid processes, in the back parts of either jaw-bone. The *œsophagus* again is the tube which conveys the food down into the stomach, and this bag of the pharynx is the expanded or trumpet-like end of it; or it may be compared with the mouth of a funnel. Towards the mouth, the pharynx is bounded by the root of the tongue, and by the arches of the throat; behind, it lies flat and

* Some of its posterior fibres mix with the constrictor pharyngis superior and palate pharyngeus.

† Named *GLOSSO STAPHILINUS*, from its origin in the tongue, and insertion into the *UVULA*.

‡ The *SALPINGO PHARYNGEUS* of Albinus, is no more than that part of the palato-pharyngeus which arises from the mouth of the Eustachian tube.

§ In its passage down, its fibres are mixed with the stylo-pharyngeus, and in its insertion they are mingled with the inferior constrictors.

smooth along the bodies of the vertebræ; before, it is protected, and in some degree surrounded by the great cartilages of the larynx; the horns of the os hyoides embrace its sides, and it is covered with flat muscular fibres, which, arising from the os hyoides and cartilages of the throat, go round the pharynx in fair and regular orders, and are named its constrictors, because they embrace it closely, and their contractions force down the food.

LIII. The **STYLO-PHARYNGEUS** arises from the root of the styloid process. It is a long slender and beautiful muscle; it expands fleshy upon the side of the pharynx; extends so far as to take a hold upon the edge of the thyroid cartilage; it lifts the pharynx up to receive the morsel, and then straightens and compresses the bag, to push the morsel down, and by its hold upon the thyroid cartilage it commands the larynx also, and the whole throat.

The pharynx being surrounded by many irregular points of bone, its circular fibres or constrictors have many irregular origins. The constrictor might fairly enough be explained as one muscle, but the irregular origins split the fibres of the muscle, and give occasion of dividing the constrictor into distinct parts; for one bundle arising from the occipital bone and os petrosum, from the tongue, the pterygoid process, and the two jaw-bones, is distinguished as one muscle, the constrictor superior.* Another bundle arising from the os hyoides is named the constrictor medius.† A third bundle, the lowest of the three, arising from the thyroid and cricoid cartilages, is named the constrictor inferior.‡

LIV. The **CONSTRICtor SUPERIOR** arising from the basis of the skull, from the jaws, from the palate, and from the root of the tongue, surrounds the upper part of the pharynx; and it is not one circular muscle, but two muscles divided in the middle line behind, by a distinct rapha, or meeting of the opposite fibres.§

LV. The **CONSTRICtor MEDIUS** rises chiefly from the round point in which the os hyoides terminates; it also arises from the cartilage of the os hyoides (*i. e.*) where the horns are joined to the body. The tip of the horn being the most prominent point, and the centre of this muscle, it goes upwards

* These good opportunities of names have not been disregarded: this muscle has been named **CEPHALO-PHARYNGEUS**, **PTERYGO-PHARYNGEUS**, **MYLO-PHARYNGEUS**, **GLOSSO-PHARYNGEUS**.

† This one is named **HYOPHARYNGEUS**, or **SYNDESMO-PHARYNGEUS**, from its origin in the cartilage also of the os hyoides.

‡ This, of course, is named **THYRO-PHARYNGEUS**, and **CRICO-PHARYNGEUS**.

§ It is connected with the buccinator, the root of the tongue, and palate.

and downwards, so as to have something of a lozenge-like shape ; it lies over the upper constrictor like a second layer, its uppermost peak, or pointed part, touches the occipital bone, and its lower point is hidden by the next muscle.

LVI. The *CONTRACTOR INFERIOR* arises partly from the thyroid and partly from the cricoid cartilage ; and it again goes also obliquely, so as to overlap or cover the lower part of the constrictor medius. This, like the other two constrictors, meets its fellow in a tendinous middle line ; and so the morsel admitted into the pharynx by the dilatation of its arches, is pushed down into the œsophagus by the forces of these *contractores pharyngis*, assisted by its styloid muscles.

LVII. The *ÆSOPHAGUS* is merely the continuation of the same tube. It lies flat upon the back-bone, and it is covered in its whole length by a muscular coat, which is formed, not like this of the pharynx, of circular fibres, but of fibres running according to its length chiefly. And this muscle, surrounding the membranous tube of the œsophagus like a sheath, is named (**LVIII.**) *VAGINALIS GULÆ*.

MUSCLES OF THE TONGUE.

THE muscles of the tongue are large bundles of flesh which come from the os hyoides, the chin, and the stylo process. Their thickness constitutes the chief bulk of the tongue. Their actions perform all its motions.

LIX. The *HYOGLOSSUS* is a comprehensive name for all those which arise from the os hyoides. The muscles from the os hyoides go off in three fasciculi, and were once reckoned as distinct muscles. That portion which arises from the basis of the os hyoides was called *BASIOGLOSSUS* ; that which arises from the cartilaginous joining of the body and horn was called *CHONDROGLOSSUS* ; and that which arises from the horn itself was named *CERATOGLOSSUS* ; or the terms were all bundled together in the perplexed names of *BASIO-CHONDRO-CERATO-GLOSSUS*.

The *hyoglossus*, then, is all that muscular flesh which arises from the whole length of the os hyoides, and which, by the changing form of the bone in its basis, cartilage, and horn, has a slight mark of division, but which lie all in one plain, and need not have distinct names.

LX. The *GENIO HYOGLOSSUS* arises from the rough tubercle behind the symphysis of the chin. It has a very narrow or pointed origin ; it spreads out fan-like, as it goes towards the

tongue and base of the os hyoides ; and it spreads with radii, upwards and backwards, making the chief part of the substance of the tongue.

LXI. The LINGUALIS is an irregular bundle of fibres, which runs according to the length of the tongue ; it lies betwixt the genio hyoglossus and the hyoglossus, and as it is in the centre, and unconnected with any bone, it is named lingualis, as arising in the tongue itself.

The geneo hyoglossi muscles form by far the larger part of the tongue and lie in the very centre. They go through the whole length, (*i. e.*) from the root to the tip of the tongue, and from the radiated form of their fibres they perform every possible motion ; whence this was named by Winslow, musculus POLYCHRESTUS, for its rays proceed from one point or centre, and those which go to the point of the tongue pull the tongue backwards into the mouth. Those which go backwards thrust the tongue out of the mouth. The middle fibres acting, make the back of the tongue hollow, while the tip and the root of the tongue both rise.

The hyoglossi muscles lie on either side of the genio-hyoidæi, and make up the sides of the tongue, and their chief action would seem to be this, that the hyoglossus muscle of either side acting, the edges of the tongue would be pulled downwards, and the back rounded, the opposite of which motion is the genio-hyoidæi acting, by which the middle of the tongue is made into a groove, the edges rising, and the centre being depressed. Lastly, The styloglossus is plainly intended for drawing the tongue deep into the mouth, particularly affecting the point of the tongue.

CHAP. III.

OF THE MUSCLES OF THE ARM,

INCLUDING THE MUSCLES OF THE SCAPULA, ARM,
FORE-ARM, AND HAND.

MUSCLES OF THE SCAPULA.

THE great peculiarity of the arm is, the manner of its connexion with the breast to which it is fixed by the slight ligaments of the clavicle only : but its union to the body is secured by its strong and numerous muscles, by which indeed it may be said both to be fixed and moved. Though it were perhaps more regular to describe first the muscles of the trunk, it will be more easily and natural to describe first the broad muscles, belonging to the scapula, which cover almost the whole trunk, and hide its proper muscles, viz. those which move the ribs and spine. For the muscles which move the scapula lie upon the trunk : those which move the arm lie upon the scapula ; those which move the fore-arm lie upon the arm : and those for moving the hand and fingers lie upon the fore-arm. The leg requires but one chief motion, viz. backwards and forwards flexion and extention. It has no other motions than those of the thigh and of the knee ; but the arm requires an easy and circular motion, and its joints are multiplied ; for it has the wrist turning round ; it has the elbow for hinge-like motions ; it has the shoulder-joint upon which the arm rolls ; and to assist all these, the scapula, which is the centre of all these motions, is itself moveable : after a certain point of elevation, all the motion in raising the arm is performed, not by the motions of the shoulder-bone upon the scapula, but by the scapula upon the trunk. For whenever the shoulder-bone rises to the horizontal direction, it is checked by the acromion, which hangs over it ; and if the arm is to be raised higher still, the scapula must roll ; it turns upon the point of the clavicle, and in turning, it glides upon those muscles, which are like a cushion betwixt it and the trunk.

The muscles which move the scapula, come from the breast to move it forwards ; from the neck, to move it upwards ; from the spines of the vertebræ, to move it backwards ; and from the side, that is, from the ribs, to move it downwards.

LXII. The **TRAPEZIUS** is named from its lozenge form ; or is often named **CUCULARIS**, from its resembling the monk's cowl, hanging back upon the neck. It is one of the most

beautiful muscles in the body ; and the two muscles together cover all the shoulders and neck, with a lozenge-like form, with neat and sharp points, extending from the tip of one shoulder to the tip of the other, and from the nape of the neck quite down to the loins. It arises from the most pointed part of the occipital bone, and along the transverse spine quite to the mastoid process, by a thin membranous tendon : from this point all down the neck, it has no hold of the vertebræ, but arises from its fellow in a strong tendon, which, extending like a bow-string down the neck, over the arch of the neck, and not touching the vertebræ, till it comes down to the top of the back, is named *LIGAMENTUM NUCHÆ*. The tendon begins again to take hold of the spines of the two last vertebræ of the neck and arises from all the spinous processes of the back, downwards ; from this long origin its fibres converge towards the tip of the shoulder : it also comes a little forward over the side of the neck.

It is implanted into more than one-third of the clavicle nearest the shoulder ; into the tip of the acromion ; into the whole length of the spine, from which the acromion rises ; and its fibres arising from along the neck and back, and converging almost into a point, must have various effects, according to the different fibres which act : for those which come downwards must raise the scapula ; those which come from the middle of the back must carry it directly backwards ; those which come from the lower part of the back must depress it ; and those different fibres acting in succession, must make the scapula roll. The trapezius is chiefly a muscle of the scapula, but it must be also occasionally a muscle of the head, pulling the head backwards, and bending the neck.

Three other muscles which raise the scapula, or carry it backwards, lie so much in the same plane, and are so little divided from each other, that they might must be reckoned different portions of the same.

LXIII. *LEVATOR SCAPULÆ*, named also *LEVATOR P OPRIVS ANGULARIS*, is a small thin slip of flesh, which arises from the four or five uppermost vertebræ of the neck, at their transverse processes, by three or four and sometimes five distinct heads. The heads join to form a thin and flat stripe of muscle, about three inches in breadth, which is fixed by a flat thin tendon to the upper corner of the scapula, to pull it upwards, as in shrugging the shoulders ; whence it is named *MUSCULUS PATIENTIÆ*.

LXIV. and **LXV.** The *RHOMBOID MUSCLE* stretches flat, neat, and of a square form betwixt the spine and the whole line of the base of the scapula. One part arises from the three lower spinous processes of the neck, and is implanted into the

base of the scapula higher than the rising of the spine of the scapula ; another portion arises from the spinous processes of the first four vertebræ of the back, runs exactly in the same plane with the other into the base of the scapula below the spine.* The part arising from the three vertebræ of the neck is slightly divided from that which arises from the four vertebræ of the back, though not distinctly, and often not at all. I would reckon this but one muscle, but it has been commonly distinguished into (LXIV.) the RHOMBOIDEUS MINOR, the uppermost portion, and (LXV.) the RHOMBOIDEUS MAJOR, the lower portion. These are seen after raising the trapezius ; and the uses of the trapezius, levator scapulæ, and rhomboideus, are to raise the scapula, or to carry it backwards. The muscles which move the scapula downwards and forwards, viz, the pectoralis minor and the serratus major anticus, lie upon the forepart of the breast.

LXVI. The SERRATUS MAJOR ANTICUS lies upon the side of the chest arising from the ribs ; and as the ribs have interstices betwixt them, every muscle arising from the ribs arises by distinct portions from each rib all such distinct and pointed slips are named digitations, tongues, or serræ, from their resembling the teeth of a saw ; and every muscle arising from the ribs must be a serrated muscle. The serratus major anticus is that great and broad muscle, the chief part of which lies under the scapula ; and nothing of which is seen but the fleshy tongues, by which it arises from the sides of the ribs. It is all fleshy, and is of a considerable breadth and strength ; it arises from all the true ribs ; it sometimes misses the first rib ; and from three of the false ribs : its indigitations, of course, spread all over the side of the thorax like a fan : its upper indigitations lie under the pectoralis major, and its lower indigitations are mixed with the beginning of the external oblique muscle of the abdomen. Its middle indigitations are seen spreading upon the sides of the thorax : it lies thick and fleshy under the scapula, and is a part of that cushion on which the scapula glides : its fibres converge towards a narrower insertion ; and the muscle ends thick and fleshy in the whole length of that line which we call the basis of the scapula, and is as it were folded round it ; so that this muscle, which comes from before, is implanted along with the rhomboideus, which comes from behind.

Perhaps, in difficult breathing, the shoulder-blade being raised and fixed by its own muscles, the serratus major may

* We frequently indeed almost find that the rhomboideus major takes also an origin from, the 7th cervical vertebræ : it is so expressed in Albinus.

assist in heaving up the ribs ; but its chief operation is upon the scapula ; for when the whole acts, it pulls the scapula downwards and forwards. When only the lower portions act, it pulls the lower angles of the scapula forwards, by which the scapula rolls, and the tip of the shoulder is raised ; when the upper part acts in conjunction with the little pectoral muscle, the tip of the shoulder is fixed and pulled downwards towards the chest, and the lower corner of the scapula rolls backwards.

LXVII. The *PECTORALIS MINOR* lies under the pectoralis major, close upon the ribs ; and as it arises from the third, fourth, and fifth ribs, it sometimes takes its origin from the second, third, and fourth ribs, and sometimes only from the third and fourth : it also is a serrated muscle, and was named *serratus minor anticus* : its three digitations are very thick and fleshy : they soon converge so as to form a small, but thick and fleshy muscle, which terminating in a point, is inserted into the very apex of the coracoid process : by pulling the coracoid process forwards and downwards, it will roll the shoulder.

LXVIII. The *SUBCLAVIAN MUSCLE* is another concealed muscle of the scapula ; for the clavicle is just the hinge upon which the scapula moves, and the subclavian muscle arises by a flat tendon from the cartilage of the first rib ; it becomes flat and fleshy, and lies along betwixt the clavicle and the first rib ; it arises at a single point of the rib, flat and tendinous : but it is inserted into a great length of the clavicle, beginning about two inches from the sternum, and being inserted all along the clavicle, quite out to where it is joined to the acromion process : its chief use (since the rib is immoveable) must surely be to pull the clavicle, and consequently the shoulder downwards, and so to fix them.

Many have affected to find other muscles of respiration than those which directly belong to the ribs. Among these are reckoned the *serratus major*, the *pectoralis minor*, &c. ; but there is much reason to doubt whether any muscles can have much effect which do not belong properly to the ribs : and it is manifest, that the subclavian can have none, since the first rib is quite rigid, has so little length of cartilage, that it cannot bend nor move.

The scapula is thus moved in every possible direction upwards, by the levator and the trapezius : backwards by the rhomboideus, assisted by the middle portions of the trapezius ; downwards and backwards by the lowest order of fibres in the trapezius ; downwards and forwards by the *serratus major anticus* ; directly downwards by the *serratus*, balanced by the

trapezius, and assisted by the subclavius; and directly forwards by the pectoralis minor.

MUSCLES OF THE ARM;

VIZ. THOSE MOVING THE OS HUMERI, OR ARM-BONE.

LXIX. The **PECTORALIS MAJOR** is a large, thick, and fleshy muscle which covers all the breast. It arises from the half of the clavicle next the sternum; from all the edge of the sternum, the cartilaginous endings of the three lower true ribs.*—Where it arises from the sternum, it is tendinous, and the fibres from the opposite muscles cross and mix, so as to make a sort of fascia covering the bone. It is fleshy where it arises from the ribs, and there it mixes with the external abdominal muscle. The fibres approach each other till they form a flat tendon about an inch in breadth: and as the fibres approach each other, they cross in such a way, that the lower edge of the muscle forms the upper edge of the tendon, which is still flat but twisted: its implantation is into the edge, if I may call it so, of the groove or rut of the biceps tendon. That part which arises from the clavicle is a little separated from that which arises from the sternum; a fatty line makes the distinction; and they are sometimes described as two parts; it is those two bundles chiefly which cross each other to make the plaited appearance. The pectoralis, among others, has been made a muscle of respiration.†

LXX. The **LATISSIMUS DORSI** is the broadest, not only of the back, but perhaps of the whole body. It is a beautiful muscle, covering all the lower part of the back and loins, and reaching to the arm, to be the antagonist to the pectoral muscle. It arises by a broad, flat, and glistening tendon, which covers all the loins, and which is in some degree the root of other muscles, especially of the longissimus dorsi. This broad silvery tendon begins exactly in the middle of the back: it arises from the lower vertebræ of the loins, from the spines and knobs

* We frequently find slips running as distinct muscles from the 7th and 8th rib to the humerus; they have been remarked, in the Windmill Street dissecting-room, more frequently in Lascars and Negroes than in Europeans. In December 1814, a body was dissected, in which there was found on both sides a slip of fibres 18 inches long, extending from the 4th and 5th rib to the fascia, between the triceps and brachialis internus, and a distinct slip of tendon might be traced even to the inner condyle.

† Haller tells us, that when, at any time, he had rheumatism in this muscle, his breathing was checked; and when he had difficult breathing, he found great relief by fixing the hands, raising the shoulders, and acting with the pectoral muscles. It seems confirmed by these facts, that asthmatics take this posture; women in labour fix their arms, by resting upon the arms of their chair; those who play on wind instruments raise their shoulders in straining.

of the back of the sacrum, and from the back part of the circle of the os ilium; this last is the only part that is fleshy. The flat tendon gradually passes into a flat and regular muscle, which wraps round the side of the body, and as it lies over the corner of the scapula, it sometimes receives a small fleshy bundle from it; and as it passes over the four lower ribs, it has some tendinous slips sent into it, by which it is attached to the ribs. Its fibres converge: for the lower ones ascend; the upper ones go directly across. And these different orders not only meet to form its flat tendon, but they cross each other, like those of the pectoral muscle: here also the tendon is twisted, and the upper edge of the muscle forms the lower edge of the flat tendon; which passing into the axilla, turns under the arm-bone, and is implanted into it, on the inner edge of the bicipital groove; so the tendons of the pectoralis and latissimus meet each other; they, in fact, join face to face, as if the one tendon ended directly in the other; and both united, make a sort of lining for the groove, or a tendinous sheath, for the long tendon of the biceps to run on.

These two muscles form the axilla or arm-pit; and although each has its peculiar offices, their chief operation is when they coincide in one action; and that action is exceedingly powerful, both by the great strength of either muscle, and by their being implanted into the arm-bone, four inches below its head. The pectoralis major is for pulling the arm forwards, as in laying, the arms across the breast, or in carrying loads in the arms; and it forms the border of the axilla before. The latissimus dorsi has a wider range; when the arm is raised, it brings it downwards as in striking with a hammer, or downwards and backwards, as in striking with the elbow, or in rolling the arm inwards and backwards, as in turning the palm of the hand behind the back, whence it has the obscene name of *MUSCULUS SCALPTOR ANI*, or *TENSOR ANI*: and it forms the back edge of the axilla. The edges of these two muscles receive the pressure of crutches, and defend the vessels and nerves; when both muscles act, the arm is pressed directly downwards, as in rising from our seat, or in holding a bundle under the arm; or when the arm is fixed, these muscles raise the body as in the example just mentioned, of rising from our seat, or in walking with a short stick, or in raising ourselves by our hands over a high beam.

LXXI. The *DELTOIDES* is the first of those muscles which arise from the scapula, to be inserted into the shoulder-bone. It is named deltoid muscle, from its resembling the letter Δ of the Greeks; it is thick and fleshy, and covers the top of the shoulder, filling up the space betwixt the acromion process and

the shoulder-bone ; it arises from all that part of the clavicle, which is not occupied by the pectoralis muscle, and is separated from it only by a fatty line ; it arises again in another bundle, from the point of the acromion process, and this middle bundle is also insulated by a fatty line on either side of it. The third bundle arises from the spine of the scapula, behind the acromion process, and which is also attached to the base by a strong ligamentous fasci, which covers the infra spinatus muscle. And thus the muscle has three converging heads, viz. a head from the outer end of the clavicle, a head from the acromion, or tip of the shoulder, a head from the ridge of the spine, each divided from the other by a fat line.* These heads or bundles of fibres, meeting about one-third down the humerus, form a short, flat, and strong tendon, which grasps or almost surrounds the shoulder-bone.

These three distinct heads must be observed in speaking of the use of the muscle, for though the chief use of the muscle be to raise the arm, this is not the use of it in all circumstances ; for the outer and inner heads lying by the side of the shoulder-bone, and below the joint, do, when the arm is lying flat by the side, assist the pectoral and latissimus dorsi muscles in drawing it close to the side. But when the middle bundle raises the arm, in proportion as the middle bundle raises the arm, it loses of its power ; and in proportion as it loses of its power, the side portions, having come into a new direction, begin to help : nay, when the arm is raised to a certain point, more power still is required, and the clavicular part of the pectoral muscle also comes to assist. It is in this succession, that the several bundles of fibres act ; for if they began all at once to act, the arm should rather be bound down by the lateral portions, than raised by the middle one.

LXXII. CORACO BRACHIALIS.—The coraco brachialis, so named from its origin and insertion, is a long and rather slender muscle.

It arises from the coracoid process of the scapula, along with the short head of the biceps muscle, and it is closely connected with this head, almost its whole length : it is small at its beginning ; it grows gradually thicker as it descends ; it is all fleshy, and is inserted by a very short tendon into the os humeri, nearly about its middle, betwixt the brachialis and the third head of the triceps. It is perforated by the external cutaneous nerve. This was observed by Casserius, an Italian anatomist ; and the muscle is often named **MUSCULUS PERFORATUS CASSERII.**

* Albinus has distinguished it into seven fasciculi or bundles ; a very superfluous accuracy.

Its action is very simple, to raise the arm obliquely forwards and upwards, and consequently to give a degree of rotation. It will also have a chief effect in pulling the arm towards the side of the body.

LXXIII. The *SUPRA SPINATUS* is so named from its occupying the hollow of the scapula above the spine.

It arises from the back of the scapula, reaching to the base, from the spine, and from the superior edge or *costa*; it is exceedingly thick and fleshy, filling up all the hollow between the spine and superior *costa*; and it is firmly enclosed in this triangular hollow, by a strong tendinous expansion, which passes from the superior edge of the scapula, to the ridge of the spine: it is consequently a muscle of a triangular figure, thick and strong; it passes under the *acromion*, and degenerates into a tendon there, and going under the *acromion*, as under an arch, and over the ball of the humerus, it adheres to the capsule of the shoulder-joint, and is at last implanted by a broad strong tendon into the upper part of the great tuberosity on the head of the bone.

It is evidently designed for raising the humerus directly upwards, and by its attachment to the capsule, the capsule is drawn up when the arm is raised, so that though lax, it cannot be caught in the joint. It exactly performs the same motion with the middle part of the *DELTOIDES*, lies in the same direction with it, and assists it.

LXXIV. *INFRA SPINATUS*, is like the former in all respects, of the same use, and assisting it.

This also is of a triangular shape and is fully one half larger than the *supra spinatus*; and the *supra spinatus* arises from all the triangular cavity above the spine: this arises from almost all the triangular cavity below it.

It arises fleshy from all the back of the scapula below the spine, except that part giving origin to the *teres major* and *minor*, from the spine itself, and from all the base of the scapula, below the beginning of the spine, and also from the greater part of the lower *costa* of the scapula. It is very thick and strong, almost filling up the triangular cavity, and it is closed in like the former, by a strong tendinous expansion; it begins to grow tendinous about its middle but it continues also fleshy till it passes over the socket of the shoulder-joint: it also is connected with the capsular ligament, is inserted into the middle of the same tuberosity with the former, and has exactly the same uses, *viz.* preventing the capsule from being caught in the joint, and raising the arm upwards, and inclining it a little outwards, by a slight degree of rotation. And I do believe, that one great use of

these two muscles is, when the arm is much extended backwards, to prevent the head of the humerus from starting out of its superficial socket.

LXXV. The *TERES MINOR* is a third muscle which co-operates with these. This and another are so named from their appearance, not from their shape, for they seem round when superficially dissected, because then their edges only are seen: but when fully dissected from the other muscles, they are rather flat. The *teres minor* is a long, small, fleshy muscle; it arises from the angle, and all the lower edge of the scapula: it is like the *infra spinatus*; it becomes early tendinous; but the tendon is accompanied with fleshy fibres from below; its flat tendon, in passing over the joint, is attached to the capsule, and is finally inserted into the great tuberosity of the shoulder-bone, so that it must have exactly the same uses as the two former muscles. It is separated from the *infra spinatus* by that tendinous expansion with which the latter is covered; it looks like a part of the same muscle in its origin, where it lies upon the scapula; but it is very distinct in its tendon. The *supra spinatus*, *infra spinatus*, and *teres minor*, raise the arm.

LXXVI. The *TERES MAJOR* is in shape like the former, lies lower upon the edge of the scapula than the *teres minor*, and is thicker and longer than it.

It arises chiefly from the angle of the scapula; partly from the lower edge of the scapula, at its back part; it is connected with the *TERES MINOR*, and *INFRA SPINATUS*. It is a large, thick, and flat muscle, and forms a flat strong tendon, which passes under the long head of the *triceps*; it passes under the *os humeri*; turns round it, and is inserted into the ridge, on the inner side of the groove, and gives some tendinous fibres to line the groove. In short, it accompanies the tendon of the *latissimus dorsi*, is inserted along with it, and may be considered as the congenor of the *latissimus dorsi*; and the two tendons are enclosed in one common capsule, or sheath of cellular substance.

Its use, then, is evidently to draw the humerus downwards and backwards, and to perform the same rotation of the arms, which the *latissimus dorsi* does.

LXXVII. The *SUBSCAPULARIS* lines all the concavity of the scapula like a cushion. It is like the surface of the scapula on which it lies, of a triangular shape; and from the convergence of all the fibres it is completely radiated or fan-like; it is very fleshy, thick, and strong; the radii are each minutely described by *Albinus*; but *Sabattier* says, with good sense, that he cannot distinguish them, so as to describe them accurately; and he might have added, that there was not the shadow

of a motive for wasting time in so trivial an employment as counting the bundles.

It arises from the two costæ, the base and all the internal surface of the scapula. And indeed it is to favour this origin that the inner surface of the scapula is full of little risings and hollows, to every one of which the muscle adheres closely. Just under the coracoid process, is the only part from whence it does not arise. That little space is filled up with cellular substance.

Its alternately tendinous and fleshy fibres are so rooted in the scapula, and so attached to its risings and depressions, that it is difficultly cleaned away from the bone.

The tendon and upper edge of the muscle is almost continuous with the supra spinatus; but from the manner of its insertions, its effect is very opposite from that of the supra spinatus, for it goes round the os humeri to its insertion, and it is fixed to the lesser tuberosity, therefore it both pulls the arm backwards and downwards, and performs the rotation like the teres major, and latissimus dorsi. It is also like all the other tendons, attached to the capsule, so as to prevent its being caught; and it is particularly useful by strengthening the shoulder-joint.

OF THE MOTIONS OF THE HUMERUS.

HAVING thus described all the muscles which moves this bone, I shall review the order in which they are arranged, and mark their place and effects.

To distinguish clearly the function of each muscle, we have but to mark the point to which it is attached.

1. Those implanted above the head of the bone must raise the arm. Now the supra spinatus, infra spinatus, and teres minor, are implanted into the great tubercle, and raise the arm; and the deltoides is implanted in the same direction, and still lower, so that it performs the same action with a still greater degree of power.

2. There is implanted into the opposite, or lower part of the head, the subscapularis which, of course, draws the arm directly downwards and backwards.

3. There is implanted into the outer edge of the bicipital groove, the pectoralis major, and also the coraco-brachialis, which comes in the same direction; and these two pull the arm inwards, towards the side and forwards.

4. There are inserted into the inside, or lower side of the groove, the latissimus dorsi, and teres major, both of which pull

the arm directly backwards, as they bend under the arm, to reach their insertion. They also roll the palm inwards and backwards. And it is easy to observe in what succession those muscles must act, to describe the circular and rotary motions of the arm.

Joints are more strengthened by the origin and insertion of muscles around them, than by elastic ligaments, which yield or tear; whereas the muscles, having a living power, re-act against any separating force. They contract, or, in other words, they are strong in proportion to the violence that the joint suffers. Thus, in the shoulder the capsule is so lax, that there is a mechanical contrivance to prevent its being checked in the joint, and it is moreover so weak, that, independent of its yielding easily, it is also very easily torn; but these muscles surround the joint so fairly, that their strength and their tendinous connexions with the head of the bone are more than a compensation for the looseness of its capsular ligament. Were not the muscles thus closely attached, the shoulders would be very often displaced, the glenoid cavity is so superficial, and the bursa so lax; and surely it is for some such purpose, that the muscles are planted so closely round the head; for when they are implanted at a distance from the centre, as one muscle, the deltoid, is, or as the biceps and triceps of the arm, or the ham-strings, or tendo Achillis, the power is much increased. Here, in the muscles arising from the scapula, power is sacrificed to the firmness of the joint, and they are all implanted closely round the head of the bone.

The connexion of the bones in this joint is in a manner formed by these muscles, for the supra spinatus, infra spinatus, teres major and minor, and the subscapularis, surround the joint very closely, cover the joint with their flat tendons, and so thicken the capsule, and increase its strength.

The muscles of the fore-arm are only four, the BICEPS and BRACHIALIS for bending, and the TRICEPS and ANCONÆUS for extending.

LXXVIII. BICEPS BRACHII FLEXOR is universally named BICEPS, from its having two very distinct heads. It is an exceedingly thick and strong muscle, for when it contracts, we feel it almost like a hard firm ball upon the forepart of the arm, and at the upper and most conspicuous part of this ball is the union of the two heads.

The larger and thicker head arises from the coracoid process, by a tendon which extends three inches along the forepart of the muscle, in the form of an aponeurosis, but at the back part the tendon is short, and the muscle is attached there to the fleshy belly of the coraco-brachialis.

The second or long head, arises from the edge of the glenoid cavity, at its upper part; it is exceedingly small and tendinous, and this long tendon runs down in its proper groove, till about the third part down the humerus the two heads meet. And though below this it is but one fleshy belly, yet here, as in other muscles, the common division betwixt its two origins may be still observed.*

It is earlier tendinous at the forepart and outer side; the tendon here sends off that aponeurotic expansion which covers all the arm below, and encloses the muscles as in a sheath. The tendon, at first flat and large, becomes gradually smaller and rounder; it turns a little in its descent, so as to lay one flat edge to the radius, and another to the ulna; and it is at last implanted into that round tubercle, which is on the forepart of the radius a little below its neck; but it has also an insertion into the fascia of the fore-arm.

The great use of the biceps is to bend the fore-arm with great strength. But as it is inserted into the tubercle of the radius, when the arm and hand are turned downwards, it by acting, will pull them upwards, (*i. e.*) it will assist the supinators. Since both its heads are from the scapula, it will occasionally move the humerus, as well as the fore-arm.

LXXIX. The *BRACHIALIS INTERNUS* lies immediately under the biceps, and is a very strong fleshy muscle for assisting the biceps in bending the arm. It is called *BRACHIALIS*, from its origin in the fore-arm, and *INTERNUS*, from its being within the biceps.

It arises from two-thirds of the *os humeri* at its forepart, by a sort of forked head; for it comes down from each side of the deltoid. It continues its attachment all the way down the forepart of the humerus, to within an inch of the joint. It is very thick, fleshy, and strong; it is tendinous for about two inches in its forepart; and is inserted by a flat strong tendon into the coronoid process of the ulna.

Other uses are ascribed to it, as the lifting up the capsule to prevent its being pinched. But the chief use of it is to bend the fore-arm. In a strong man, it is exceedingly thick, and its edge projects from under the edge of the biceps, and is seen in the lateral view.

LXXX. *TRICEPS EXTENSOR*.—Upon the back part of the arm three muscles have been described: the extensor longus, the extensor brevis, and the brachialis externus; but there is, in fact, only one three-headed muscle.

* It is not uncommon to find a third head to this muscle, which takes an origin from the forepart of the humerus.

The longest head of this muscle is in the middle. It arises by a flat tendon ; from an inch of the edge of the scapula under the neck, and a little way from the origin of the long head of the biceps ; and it is under this head that the tendon of the *teres major* passes to its insertion.

The second head is on the outside of the arm, next in length to this. It arises from the arm-bone under the great tubercle, and just below the insertion of the *teres minor*. The long and second heads meet about the middle of the humerus.

The third, or internal head, is the shortest of all. It begins at the inner side of the humerus, just under the insertion of the *teres major* ; and it arises from the inner part of the humerus, all the way down, and joins just where the second head joins (*i. e.*) about the middle. All these heads still continue adhering to the humerus (as the *brachialis* does on the fore-side,) quite down to within an inch of the joint, and then a strong thick tendon is formed, by which it is implanted strongly in the projecting heel of the ulna, named *olecranon*, by which projection of the bone the muscle has great power, and the power is increased by an increased length of the process in dogs, and other animals which run or bound.

The whole forms a very thick and powerful muscle, which covers and embraces all the back part of the arm ; and its use is too simple to admit of any further explanation, than just to say that it extends the hinge-joint of the elbow with great power ; and that by its long head it may assist also to bend the arm-bone outwards and backwards.

Besides bones, there is also another source of attachment for muscles, that is, the tendinous expansions : for the expansions, which go on the surface like sheaths, also dive betwixt the muscles, and form septa, or partitions, from which their fibres arise.

One tendinous expansion begins from the clavicle and acromion process, or rather comes down from the neck : it is then strengthened by the tendon of the *deltoid* muscle ; it descends, covering all the arm ; and before it goes down over the forearm, it is again re-enforced chiefly by the *biceps*, but also by the tendon of the *triceps extensor*. One remarkable process, or partition of this general fascia, is sent in from the sheath to be fixed to the outside of the humerus, all the way down to the ridge of the outer condyle. Another partition goes down, in like manner, to the inner condyle, along the ridge which leads to it ; then the fascia, taking a firm hold on the condyles, is greatly strengthened about the elbow, and goes over the forearm, enclosing its muscles in a very firm and close sheath ; and

it sends partitions down among the several layers of muscles in the fore arm, which gives each of them a firm hold.

LXXXI. The ANCONÆUS is a small triangular muscle, placed on the back part of the elbow. It arises from the ridge and from the external condyle of the humerus, by a thick, strong, and short tendon. From this it becomes fleshy, and after running about three inches obliquely backwards, it is inserted by its oblique fleshy fibres into the outer part of the ridge of the ulna.

It is manifestly designed for the extension of the fore-arm, and has only that one simple action.

MUSCLES OF THE FORE-ARM, CARPUS, AND FINGERS.

The whole fore-arm is covered with a mass of muscles of great strength, and so numerous and intricate, with a catalogue of names so difficult, and so distracting, that they should be arranged and classed with much care, explaining to the student the reason and value of their names, and the place and effect of each class.

The fore-arm is covered with a fascia, or strong tendinous web, which, like that which covers the temporal muscle, give both origin and strength to the muscles which lie under it, which divides the several layers one from another, and helps them in their strong actions, with that kind of support which workmen feel in binding their arms with thongs. This fascia is said to proceed from the small tendon of the biceps muscle, though that were but a slender origin for so great a web of tendon, which not only covers the surface of the muscles, but enters among their layers. This fascia really begins in the shoulder, and has an addition and an increase of strength from every point of bone; it is assisted by each tendon, because the tendons and fascia are of one nature over all the body, and its connexion with the tendon of the biceps is quite of another kind from that which has been supposed. I would not allow that the biceps tendon expands into the fascia, but rather that the web receives the biceps tendon, which is implanted into it, and for this wise purpose, that when the fore-arm is to strike, or the hand to grasp, the biceps first moves, and by making the fascia tense, prepares the fore-arm for those violent actions which are to ensue. Thus, it may be defined, a web of thin but strong tendon, which covers all the muscles of the fore-arm makes the surface before dissection firm and smooth, sends down partitions which are fixed into the ridges of the radius and ulna, enabling those bones to give a broader origin to the

muscles, establishing a strong connexion among the several layers, and making the dissection more difficult.

The motions to be performed by the muscles which lie upon the fore-arm are these three; to roll the hand, to bend the wrist, to bend the fingers.

1. The turning of the hand, which is performed by rolling the radius on the ulna, is named pronation and supination. When we turn the palm down, it is said to be prone; when we turn the palm upwards, it is supine. This is pronation and supination. The muscles which perform these motions are the *PRONATORS* and the *SUPINATORS*, and the motion itself is best exemplified in the turning a key in a lock, or in the guards of fencing, which are formed by a continual play of the radius upon the ulna, carrying the wrist round in the half circle.

2. The wrist is called the *CARPUS*, and therefore those muscles which serve for bending or extending the wrist are the *FLEXORS* and *EXTENSORS* of the carpus.

3. The bending and extending of the fingers cannot be mistaken, and therefore the flexors and extensors of the fingers need not be explained.

These muscles are denominated from their uses chiefly; but if two muscles perform one motion, they may be distinguished by some accident of their situation or form. And thus, if there be two benders of the fingers, one above the other, they are named *FLEXOR SUBLIMIS* and *FLEXOR PROFUNDUS*, (*i. e.*) the superficial and deep flexors. If there be two flexors of the carpus, one is named *FLEXOR RADIALIS CARPI*, by its running along the radius, the other *FLEXOR ULNARIS CARPI*, from passing in the course of the ulna. And if there be two pronators, one may be distinguished pronator teres, from its round shape, the other pronator quadratus, from its square form. And this, I trust, will serve as a key to what is found to be a source of inextricable confusion.

It will be easy to make the origins and insertions still more simple than the names; for all the muscles arise from two points, and have but two uses.

This assertion shall be afterwards qualified with a few exceptions; but at present it shall stand for the rule of our demonstration; for all the muscles arise from two points, the external and internal condyle. The internal condyle is the longer one, and gives most power: more power is required for bending, grasping, and turning the hand inwards; therefore all the muscles which bend the hand, all the muscles which bend the fingers, and the principal pronator, or that muscle which turns the palm downwards, arise from the internal condyle.

The external condyle is shorter; it gives less power; there

is little resistance to opening the hand and little power is required in extending the fingers; and so all the muscles which extend the wrist or the fingers, or roll the hand outwards to turn it supine, arise from the external condyle. So that when we hear a pronator or a flexor named, we know that the origin must be the internal condyle, and the insertion is expressed by the name. Thus a pronator radii goes to the radius; a flexor carpi goes to the wrist: a flexor digitorum goes to the fingers; and a flexor pollicis goes to the thumb: and they all issue from the inner condyle as from a centre.

And again, when a supinator or extensor is named, we know where to look for it; for they also go out from one common point, the external condyle; and the supinator radii goes to the radius; the extensor carpi goes to the wrist; the extensor pollicis goes to the thumb; and the extensor indicis to the fore finger.

LEXORS.

The MUSCLES closing and bending the hand arise from the internal condyle. They are,

The PRONATOR TERES, rolling the radius inward.

PALMARIS LONGUS,

FLEXOR CARPI RADIALIS,

————— ULNARIS,

————— DIGITORUM SUBLIMIS,

————— PROFUNDUS,

————— LONGUS POLLICIS,

} bending the wrist.

} bending the fingers
and thumb.

And, lastly, the PRONATOR QUADRATUS, which is the single muscle out of that scheme which I have proposed.*

LXXXII. The PRONATOR TERES RADII is of the outermost layer of muscles, is small and round; named pronator from its

* Mr. Charles Bell in his Lecture, varies this arrangement. He observes that a kind of artificial memory of the muscles of the fore-arm may be had, by arranging them in numbers: for example, if we take the biceps flexor as supinator in this instance, which it truly is, and the mass of the flexor muscles as one great pronator, for such is their conjoint operation, then the muscles go in threes—thus:

For the motion of the wrist, three flexors, the ulnaris, radialis, and medius, commonly called palmaris longus. Three extensors, ulnaris radialis longior, and brevior. Three pronators, the teres, quadratus, and the mass of flexor muscles. Three supinators, the supinator longus, brevis, biceps cubiti. There are three extensors of the fingers, extensor communis digitorum, extensor primi digiti, extensor minimi digiti. Three extensors of the thumb, extensor primus, secundus, and tertius. Three flexors of the fingers and thumb, flexors digitorum sublimis, flexor digitorum profundus, flexor pollicis longus. In the arrangement of the muscles of the fore-arm, it is correct to say that the flexors arise from the inner condyle and the extensors from the outer condyle; but the supinators and pronators are better distinguished by their insertion: thus, all muscles inserted into the radius turn the wrist, and thus the supinator longus, the supinator brevis, the pronator teres, the pronator quadratus, and the biceps, are employed in turning the hand.

office of turning the radius, and teres from its shape, or rather to distinguish it from the pronator quadratus, which is a short square muscle, and which lies deep, being laid flat upon the naked bones.

The pronator teres arises chiefly from the internal condyle of the humerus, at its lower and forepart. It has a second origin from the coronoid process of the ulna; these form two portions, betwixt which passes the radial nerve. The muscle thus formed is conical, is gradually smaller from above downwards, is chiefly fleshy, but is also a little tendinous, both at its origin and at its insertion; and stretches obliquely across the fore-arm, passing over the other muscles to be inserted in the outer ridge of the radius, about the middle of its length.

Its use is to turn the hand downwards, by turning the radius; and it will also, in strong actions, be brought to bend the fore-arm on the arm, or the reverse, when the fore-arm is fixed, and we are to raise the trunk by holding with the hands.

LXXXIII. The PALMARIS LONGUS is a long thin muscle, which, although it seems to have another use in its expansion into the aponeurosis, yet is truly, by insertion into the annular ligament of the wrist, a flexor of the wrist, and, in some degree, a pronator of the radius.

It arises from the internal condyle of the os humeri, and is the first of five muscles which have one common tendon going out, like radii, from one common centre, viz. the palmaris: the flexor radialis; the flexor ulnaris; the flexor digitorum sublimis; the flexor digitorum profundus.

The palmaris longus arises from the inner condyle of the os humeri, and also from the intermuscular tendon, which joins it with the flexor radialis and flexor digitorum sublimis, and from the internal surface of the common sheath. Its fleshy belly is but two inches and a half or three inches in length; and its long slender tendon descends along the middle of the fore-arm to be inserted into the forepart of the annular ligament of the wrist, just under the root of the thumb. This tendon seems to give rise to the very strong thick aponeurosis of the palm of the hand, (under which all the muscles of the hand run, and which conceals the arch of blood-vessels and protects them,) thence the muscle has its name. But it is a very common mistake to think, that because tendons are fixed to the sheaths, the sheaths are only productions of the tendons; whereas the sheaths do truly arise from bones. The fascia, which the deltoides is thought to form, arises from the acromion and clavicle; and the fascia, which the biceps is thought to produce, arises from the condyles of the humerus; and that great sheath of tendon which is made tense by the musculus fasciæ of the thigh, does

not arise from that muscle, but comes down from the spine of the ilium, strengthened by expansions from the oblique muscles of the abdomen; in the present instance, we have the clearest proof of fascia being derived from some other source than the tendons, for sometimes the palmaris muscle is wanting, when still the tendinous expansion is found, and some pretend to say, that the expansion is wanting when the muscle is found. The aponeurosis, which covers the palm, is like the palm itself, of a triangular figure; it begins from the small tendon of the palmaris longus, and gradually expands, covering the palm down to the small ends of the metacarpal bones. Its fibres expand in form of rays; and towards the end there are crossbands which hold them together, and make them stronger; but it does not cover the two outer metacarpal bones, (the metacarpal of the fore-finger, or of the little finger,) or it only covers them with a very thin expansion.

Now this palmar expansion also sends down perpendicular divisions, which take hold on the edges of the metacarpal bones: and thus there being a perpendicular division to each edge of each metacarpal bone, there are eight in all, which form canals for the tendons of the fingers, and for the lumbricales muscles.*

LXXXIV. The *PALMARIS BREVIS* is a thin flat cutaneous muscle, which arises properly from the edge of the palmar aponeurosis, near to the ligament of the wrist; whence it stretches across the hand in thin fasciculi of fibres, which are at last inserted into the os pisiforme, and into the skin and fat on the ulnar edge of the palm. This is the *PALMARIS CUTANEUS* of some authors, for which we can find no use, except of drawing in the skin of the hand, and perhaps making the palmar expansion tense.

LXXXV. The *FLEXOR CARPI RADIALIS* is a long thin muscle arising from the inner condyle, stretching along the middle of the fore-arm somewhat in the course of the radius, and is one of the five muscles which rise by one common tendon, and which are, for some way, tied together.

It arises tendinous from the inner condyle; the tendon very short and thick. This tendon at its origin is split into many (seven) heads, which are interlaced with the heads of the sublimis, profundus palmaris, &c.; consequently this muscle not only arises from the internal condyle, but also from the intermuscular partitions (as from that betwixt it and the sublimis:) it forms a long tendon, which, becoming at last very small and

* There is a great irregularity in this muscle; it is frequently wanting, and it is not uncommon to find two. We have found more than once, that the tendinous part of the muscle was next to the condyle, and the fleshy part connected with the fascia palmaris.

round, runs under the annular ligament : it runs in a gutter peculiar to itself ; but in this canal it is moveable, not fixed : it then expands a very little, and is inserted into the metacarpal bone of the fore-finger, also touching that which supports the thumb.

Its use is chiefly to bend the wrist upon the radius. But when we consider its oblique direction, it will also be very evident that it must have some effect in pronation ; and this, like many of the muscles of the fore-arm, although designed for a different purpose, will also have some effect in bending the fore-arm at the elbow-joint.

LXXXVI. The *FLEXOR CARPI ULNARIS* is a long muscle, much like the former ; but as its course is along the radius, or upper edge of the fore-arm, this runs along the ulna or lower edge.

It comes off tendinous from the inner condyle of the os humeri, by the common tendon of all the muscles : it has also, like the pronator teres, a second head, viz. from the olecranon process of the ulna, which arises fleshy, and the ulnar nerve perforates betwixt these heads. The flexor ulnaris passes all along the flat side of the ulna, betwixt the edge of the sublimis and the ridge of the bone : and here it has a third origin of oblique fibres, which come from the edge of the ulna, two thirds of its length. Its tendon begins early on its upper part, by which it has somewhat the form of a penniform muscle. It has still a fourth origin from the inter-muscular partition, which stands betwixt it and the flexor sublimis ; and is also attached to the internal surface of the common fascia of the arm. Its long tendon is at last inserted into the os pisiforme at its forepart, where it sends off a thin tendinous expansion to cover and strengthen the annular ligament ; and also a thin expansion towards the side of the little-finger to cover its muscles.

This is to balance the flexor radialis : acting together, they bend the wrist with great strength ; and when this muscle combines in action with the extensor carpi ulnaris, they pull the edge of the hand sideways.

LXXXVII. The *FLEXOR DIGITORUM COMMUNIS SUBLIMIS*, is named *SUBLIMIS* from being the more superficial of the two muscles ; *PERFORATUS*, from its tendon being perforated by the tendon of that which lies immediately below. It lies betwixt the palmaris longus and flexor ulnaris : it is a large fleshy muscle ; and not only its tendons, but its belly also, is divided into four fasciculi, corresponding with the fingers which it is to serve.

It arises from the internal condyle, along with the other

four muscles ; from the ligament of the elbow-joint ; from the coronoid process of the ulna ; and from the upper part of the radius, at the sharp ridge. By these origins, it becomes very fleshy and thick ; and, a little above the middle of the fore arm, divides into four fleshy portions, each of which ends in a slender tendon. The tendons begin at the middle of the fore-arm, or near the division, but they continue to be joined to each other by fleshy fibres some way down : and indeed the fleshy fibres cease only when it is about to pass under the annular ligament of the wrist. At this place, a cullier stringy tissue connects the tendons with each other, and with the tendons of the profundus ; but after they have passed under the ligament, they expand towards the fingers which they are to serve. They each begin to be extended and flattened, and to appear cleft ; they pass by the edge of the metacarpal bones, and escape from under the palmar aponeurosis : and where it ends, viz. at the root of the fingers, a tendinous sheath begins, in which these tendons continue to be enclosed.

The tendons are fairly split just opposite to the top of the first phalanx ; and it is at this point that the tendons of the deeper muscle pass through this splitting. The flattened tendon parts into two, and its opposite edges diverge ; the back edges meet behind the tendons of the profundus, and form a kind of sheath for them to pass in ; and then they proceed forward along the second phalanx, into the forepart of which they are implanted.

This muscle is exceedingly strong : its chief office is to bend the second joint of the fingers upon the first, and the first upon the metacarpal bone. And in proportion to the number of joints that a muscle passes over, its offices must be more numerous ; for this one not only moves the fingers on the metacarpus, but the hand upon the wrist, and even the fore-arm upon the arm.

LXXXVIII. The FLEXOR DIGITORUM PROFUNDUS vel PERFORANS, has so nearly the same origin, insertion, and use, so that the description of the last is applicable to this muscle in almost every point. This is of a lower stratum of muscles ; it lies deeper, and under the former, whence its name : and by this deeper situation it is excluded from any hold upon the tubercle of the humerus.

It arises from the ulna, beginning at the coronoid process, and extending all along its internal surface, from the whole surface of the interosseous ligament, from the inner edge of the radius, and also, in some degree from the inter-muscular membrane which separates this from the sublimis.

This muscle is small, we may say compressed above ; but it grows pretty strong and fleshy, near the middle of the arm ; it divides above the middle of the arm, into four portions, corresponding with the four fingers ; and it is about the middle of the arm that the tendons begin, and continue to receive muscular fibres from behind, all down to the ligament of the wrist : at the wrist, these tendons are tied to each other, and to the tendons of the sublimus, by loose tendinous and cellular fibres. They diverge from each other, after passing under the annular ligament ; and going along in the hollow of the bones, under the tendons of the sublimis, they first pass through the bridges formed by the palmar aponeurosis, then enter the sheaths of the fingers, and finally pass through the perforations of the sublimis, a little below the second joint of the fingers : at this place the perforating tendons are smaller and rounder for their easy passage, and after passing, they again expand and become flat. They also, above this, appear themselves to split in the middle without any evident purpose ; they pass the second phalanx, and are fixed into the root of the third. And every thing that is said of the use of the sublimis may be applied to this, only that its tendons go to the furthest joint.

LXXXIX. LUMBRICALES.—I shall here describe, as a natural appendage of the profundus, the LUMBRICALES muscles, which are four small and round muscles, resembling the earth-worm, in form and size ; whence they have their name. They arise in the palm of the hand, from the tendons of the profundus, and are therefore under the sublimis, and under the palmar aponeurosis. They are small muscles, with long and very delicate tendons. Their fleshy bellies are about the length of the metacarpal bones, and their small tendons stretch over two joints, to reach the middle of the second phalanx. The first lumbricalis is larger than the second, and the two first larger than the two last.

The first arises from the side of the tendon of the fore-finger, which is next to the radius ; the others arise in the forks of the tendons ; and though they rise more from that tendon which is next the ulna yet they have attachments to both. Their tendons begin below the first joint of each finger ; they run very slender along the first phalanx, and they gradually wind around the bone, so that though the muscles are in the palm of the hand, the tendons are implanted in the back parts of the fingers, and their final connexion is not with the bending tendons of the sublimis and profundus, but with tendons of the extensor digitorum, and with the tendons of the external interossei muscles, with which they are united by tendinous threads.

Hence their use is very evident ; they bend the first joint, and extend the second ; they perform alternately either office ; when the extensors act, they assist them by extending the second phalanx or joint : when the flexors act, and keep the first and second joint bended, the extending effect of these smaller muscles is prevented, and all their contraction must be directed so as to affect the first joint only, which they then bend.

They are chiefly useful in performing the quick short motions, and so they are named by Cowper, the *musculi fidicinales*, as chiefly useful in playing upon musical instruments.

XC. The *FLEXOR LONGUS POLLICIS* is placed by the side of the *sublimis*, or *perforatus*, and lies under the *supinator* and *flexor carpi radialis*. It runs along the inner side of the *radius* whence chiefly it arises.

Its origin is from all the internal face of the *radius* downwards, from the place where the *biceps* is inserted, and from the *interosseous ligament*, all the length down to the origin of the *pronator quadratus* : nor does it even stop here ; for the tendon continues to receive fleshy slips all the way down to the passage under the ligament of the wrist. It has also another head, which arises from the condyle of the *humerus*, and the forepart of the *ulna* ; which head is tendinous, and joins that origin which comes from the *radius*.

The muscle becomes again tendinous, very high, (*e. i.*) above the middle of the arm ; and its small tendon passes under the *annular ligament*, glides in the hollow of the *os metacarpi pollicis*, and separates the short flexor into two heads, passes betwixt the two *cesamoid bones* in the first joint of the thumb, and running in the tendinous sheath, it reaches at last the end of the farthest bone of the thumb, to be inserted into the very point of it.

There is sometimes sent off from the lower part of the muscle a small fleshy slip, which joins its tendons to the *indicator tendon* of the *sublimis*.

Its uses, we conjecture, are exactly as of those of the other flexors, to bend the last phalanx on the first, the first, on the metacarpal bones, and, occasionally, the wrist upon the *radius* and *ulna*.

XCI. The *PRONATOR QUADRATUS*, so named from its shape and form, is one of the most simple in its action, since it serves but one direct purpose, *viz.* turning the *radius* upon the *ulna*.

It lies flat upon the *interosseous ligament* upon the forepart of the arm, about two inches above the wrist ; it is nearly square, and is about three inches in length and breadth. Its

fibres go obliquely across, betwixt the radius and ulna. It arises from the edge of the ulna, adheres to the interosseous ligament, and goes to be implanted into the edge of the radius; it turns the radius upon the ulna. This muscle, and in some degree also the flexor pollicis, are the only muscles which do not come fairly under that arrangement, by which I have endeavoured to explain the muscles of the fore-arm.

EXTENSORS.

The muscles which lie upon the outer side of the fore-arm, the supinators, and the extensors of the fingers and wrist, all arise from one point, the external condyle of the humerus, and are all delivered in this list :

The EXTENSOR CARPI RADIALIS LONGIOR,
The EXTENSOR CARPI RADIALIS BREVIOR, } all extend the wrist.
The EXTENSOR CARPI ULNARIS,
The SUPINATOR LONGUS,—turns the palm upwards.
The EXTENSOR COMMUNIS DIGITORUM, extends all the fingers, and unfolds the hand.

The EXTENSOR PRIMA INTERNODII
POLLICIS,
The EXTENSOR SECUNDI INTERNODII
POLLICIS,
The EXTENSOR TERTI INTERNODII
POLLICIS, } extend the several joints of
of the thumb.

The EXTENSOR PRIMI DIGITI vel INDICATOR,—extends the fore-finger.

The EXTENSOR MINIMI DIGITI vel AURICULARIS,—extends the little-finger.

All these muscles arise from one point, the external condyle. They all roll the radius outwards, or extend the wrist, or extend the fingers. As the muscles which are bent, need more fibres, and greater strength, they arise from the internal condyle, which is the larger; they lie in the deep hollow, for the bones of the fore-arm are bent to receive them, and they form a very thick fleshy cushion: but the extensors requiring less power, arise from the shorter process of the outer condyle, are on the convex side of the arm, and are thin, having few fibres; for though there is a large mass of flesh on the inner side of the arm, forming two big flexors, there is only a thin layer on the outer side of the arm, forming one flat and weak extensor.

XCH. SUPINATOR RADII LONGUS. This muscle forms the very edge of the fore arm: it arises by many short tendinous fibres, from the ridge of the humerus, above the external con-

dyle, which origin is fully two inches in length above the condyle. It also arises from the intermuscular membrane; and, as it stands on the very edge of the fore-arm, it runs betwixt the flexor and extensor radialis. It becomes thicker as it passes the joint of the humerus, and there gives a very peculiar form to the arm: it then becomes smaller, and forms a flat tendon, which is quite naked of flesh from the middle of the radius, or a little below, down to the wrist. This tendon becomes gradually smaller, till it reaches the wrist, where expanding a little, it is inserted into the styloid process of the lower head of the radius.

Its use is, perhaps, chiefly as a supinator, but it is placed just upon the edge of the arm; it stands as a sort of intermedium betwixt the two sets of muscles; it is fixed, indeed, rather upon the internal surface of the radius; but yet when the supination is complete, when the hand is rolled very much outward it will become a pronator.

It is at once supinator and pronator, and for a most evident reason, a flexor also of the fore-arm, since its origin is at least two inches up the humerus, above the joint of the elbow.

XCIII. The *EXTENSOR CARPI RADIALIS LONGIOR*, has the additional name of *longior* or *primus*, to distinguish it from the next. It is almost entirely covered with the last muscle, the supinator.

It arises from the ridge of the humerus above the external condyle and just under the origin of the supinator; it descends all along the back of the radius; and after having become a thick fleshy belly, it degenerates a little lower than the middle of the radius, into a thin flat tendon, which becomes slender and small as it descends; and turning a little more towards the back of the radius, it then passes over the wrist, and goes along with the tendon of the extensor, under the annular ligament, passing in a groove of the radius; at last it is inserted into the root of the metacarpal bone of the fore-finger, in that edge next the thumb.

It is chiefly an extensor of the wrist: in pronation, it pulls the wrist directly backwards; in supination, it moves the hand sideways. It is also a pronator, when the hand is turned back to the greatest degree: and from its origin, high upon the arm-bone, it is also a flexor of the fore-arm.

XCIV. *EXTENSOR CARPI RADIALIS BREVIOR*.—This muscle is almost the same in description, name, and use, with the former. It arises from the external condyle; and here a common tendon for many muscles is formed, just as in the internal condyle; for from this point arise the extensor carpi radialis

brevior, extensor digitorum, extensor minimi digiti, extensor carpi ulnaris.

The extensor carpi radialis breviar arises from the order condyle of the humerus, by the common tendon ; it also arises from the aponeurosis, which lies betwixt the extensor digitorum and this ; it grows a pretty large fleshy body, and begins, like the last, to be tendinous below the middle of the radius ; so that this muscle continues fleshy lower than the last one, and its tendon is also much larger and thicker ; it runs under the annular ligament, in the same channel with the extensor longior ; it expands a little before its insertion, which is into the back part of the metacarpal bone of the middle finger, a little towards that edge which is next the radius : some little fibres pass from this tendon to the metacarpal bone of the fore-finger.

All that was said concerning the extensor longus, may be said of this ; for all the three last muscles lie so ambiguously on the edge of the arm that though they are regularly supinators and extensors, they become pronators and flexors, in certain positions of the hand.

XCV. EXTENSOR CARPI ULNARIS.—By the name merely of this muscle we know its extent and course, its origin, insertion, and use.

It is one of the muscles which belong to the common tendon, arising from the external tubercle of the os humeri ; it lies along the ulnar edge of the arm ; it also arises from the intermuscular membrane, which separates this from the extensor digitorum and the extensor digiti minimi ; and chiefly it is attached to the internal surface of the common sheath. It arises also from the face and edge of the ulna, the whole way down ; its tendon begins in the middle of its length, and is accompanied all down to the wrist with feather-like fleshy fibres.

It is fixed into the outside of the lower head of the metacarpal bone of the little-finger.

Its use is to extend the carpus. And it may be now observed, that when the two extensors of the wrist, the radialis and ulnaris act, the hand is bent directly backwards ; that when the flexor radialis and extensor radialis act together, they bend the thumb towards the radius ; and that when the flexor ulnaris and extensor ulnaris act, they draw down the ulnar edge of the hand.

XCVI. EXTENSOR DIGITORUM COMMUNIS.—This muscle corresponds with the sublimis and profundus, and antagonizes them, and resembles them in shape as in use. It covers the middle of the fore-arm at its back, and lies betwixt the extensor radialis breviar and the extensor minimi digiti.

Its origin is chiefly from the outer condyle, by a tendon common to it, with the extensor carpi radialis brevior; it comes also from the intermuscular membrane, which separates it on one side from the extensor minimi digiti, and on the other from the extensor carpi radialis brevior, and lastly, from the back part of the common sheath. It grows very fleshy and thick, as it descends, and about the middle of the fore-arm it divides itself into three slips of very equal size. But though the tendons begin so high they continue like those of the flexors, to receive fleshy penniform fibres all down, almost to the annular ligament. These tendons are tied together by a loose web of fibres, and being gathered together they pass under the ligament in one common and appropriated channel. Having passed this ligament they diverge and grow flat and large. And they all have the appearance of being split by a perpendicular line. They are quite different from the flexor tendons in this, that they are all tied to each other by cross bands; for a little above the knuckles, or first joint of the fingers, all the tendons are joined on the back of the hand by slips from the little-finger to the ring, from the ring to the mid-finger, and from that to the fore-finger. So that it seems to be one ligament running quite across the back of the hand. It would be foolish to describe them more minutely: for the cross bands change their places, and vary in every subject, and in some they are not found.

After this, the tendons pass over the heads of the metacarpal bones, along the first phalanx of the fingers, and being there joined by the tendons of the interossei and lumbricales, they all together form a strong tendinous sheath, which surrounds the back of the fingers.

Now it is to be remembered, that this muscle serves only for the fore, middle, and ring fingers: that if it moves the little-finger, it is only by a small slip of tendinous fibres, which it often gives off at the general divergence, but sometimes not; sometimes it gives one slip, sometimes two, often none at all. And so the little-finger has its proper extensor quite distinct from this.

The use of the muscle is to extend all the fingers; and when they are fixed, it will assist the extensors of the wrist, as in striking backwards with the knuckles.

XCVII. The EXTENSOR MINIMI DIGITI, named also AURICULARIS, from its turning up the little finger, as in picking the ear, should really be described with the last muscle; if we see the origin, course, and use of this muscle exactly the same with it, why should we not reckon it as a slip of the common extensor, appropriated to the little finger?

Its origin is from the outer condyle, along with the other tendons. It also adheres so closely both to the tendinous partitions, and to the internal surface of the common fascia, that it is not easily separated in dissection. It begins small, with a conical kind of head; it gradually increases in size; it is pretty thick near the wrist; it adheres all along to the common extensor of the fingers; it begins to be tendinous about an inch above the head of the ulna; it continues to receive fleshy fibres down to the annular ligament; and it passes under the annular ligament, in a channel peculiar to itself, which is indeed the best reason for making this a distinct muscle.

This channel has a very oblique direction, and the tendon, like all the others, expands greatly in escaping from the ligament of the wrist. It is connected with the other tendons, in the manner I have described. Close to the wrist, it is connected with the tendon of the ring finger, by a slip which comes from it; and at the knuckle, and below it it is again connected with the tendons both of the ring finger, and of all the others, by the cross bands or expansions.

Whatever has been said of the use of the last muscle, is to be understood of this; as its extending its proper finger, assisting the others by its communicating band, and in its extending the wrist, when the fist is clenched. Its insertion is into the back of the second joint of the little-finger, along with the interossei and lumbricales. Its tendon has also a small slit; for the head of the proper extensor of the little finger, and the heads of the common extensors of the others, are inserted into the top of the second phalanx, just under the first joint. They send off at the sides tendinous slips, which, passing along the edges of the bones, do, in conjunction with the tendons of the interossei and lumbricales, form a split tendon, which meets by two curves at the foot of the last bone of the fingers, to move the last joint.

XCVIII. The **EXTENSOR PRIMUS POLLICIS** is the shortest of the three. It is named by Albinus, and others, **ABDUCTOR LONGUS**; but since every muscle that extends the thumb must pull it away from the hand, every one of them might be, with equal propriety, named abductors.

The extensor primus lies just on the fore edge of the radius crossing it obliquely.

It arises about the middle of the fore-arm, from the edge of the ulna, which gives rise to the interosseous membrane itself, and also from the convex surface of the radius.

The fleshy belly commonly divides itself into two or three, sometimes four fleshy slips, with distinct tendons, which, crossing the radius obliquely, slip under the external ligament of

the carpus, and are implanted into the trapezium and the root of the first metacarpal bone, or rather of the first phalanx of the thumb, towards the radial edge so that its chief use is to extend the thumb, and to incline it a little outwards towards the radius. It has also frequently a tendon inserted in the abductor pollicis. It must also, like the extensors of the fingers, be an extensor of the wrist : and it evidently must, from its oblique directions, assist in supination.

XCIX. The *EXTENSOR SECUNDUS POLLICIS* is longer than the first. It is named by Douglas the *extensor secundi internodii pollicis* : by Albinus, the *extensor minor pollicis*.

This muscle lies close by the former. It arises just below it, from the same edge of the radius, and from the same surface of the interosseous membrane, it runs along with it in the same bending course ; and, in short, it resembles it so much that Winslow has reckoned it as part of the same muscle.

Its origin is from the edge of the ulna, the interosseous ligament, and the radius. Its small round tendon passes sometimes in a peculiar channel, sometimes with the *extensor primus*. It goes over the metacarpal bone of the thumb ; it expands upon the bone of the first phalanx ; and it is inserted just under the second joint.

It extends the second bone of the thumb upon the first ; it extends the first bone also ; and it extends the wrist, and by its oblique direction, contributes to supination.

C. *EXTENSOR TERTIUS POLLICIS*.—This which bends the third joint is called in common the *extensor longus pollicis*. And here is a third muscle, which in form, and place, and function, corresponds with the two former ones.

Its origin is from the ridge of the ulna, and from the upper face of the interosseous membrane ; and it is a longer muscle than the others, for it begins high, near the top of the ulna, and continues the whole way down that bone, and is very fleshy and thick. It is penniform all the way down to the ligament of the wrist ; and its small tendon passes the ligament in a peculiar ring. This tendon appears split, like those of the fingers ; it goes along the ulnar side of the first bone of the thumb, reaches the second, and is implanted there by a small slip of tendon ; and being expanded, it still goes forward, to be inserted once more into the third bone of the thumb at its root.

Its use is evident, after describing the others. For we have only to add another joint for motion. It moves the last joint of the thumb, then the second, then its metacarpal bone upon the carpus ; and if that be held firm, it will extend the carpus ; and it will, in its turn, contribute to supination, though in a less degree than the others.

CI. INDICATOR.—The *EXTENSOR INDICIS PROPRIUS* has very nearly the same origin, and exactly the same course with the last, and lies by the side of it.

Its origin is from the ulna, by the side of the *extensor longus pollicis*. It has also some little attachments to the interosseous membrane. It, like the others, is feathered with fibres, in an oblique direction, down to the ligament of the wrist.

This muscle lies under the *extensor communis digitorum*: its tendon passes along with the common tendon, through the annular ligament; and near the top of the metacarpal bone, or about the place of the common junctions of all these tendons, this one joins with the indicator tendon of the common extensor.

Its use is in extending all the three joints of the fore-finger; assisting the common extensor in pointing with that finger; in acting independently of the common extensor; and in helping to extend the wrist, when the fingers are closed.

CII. The SUPINATOR BREVIS is an internal muscle, which forms, with the muscles of the thumb and of the fore-finger a kind of second layer; and this one lies concealed, as much as the *pronator quadratus* does, on the inner side of the fore-arm. It is a short muscle, but very thick and fleshy, and of great power.

It arises from the outer condyle of the *os humeri*, and from the edge of the ulna, and from the interosseous ligament: it is then lapped over the radius, and is inserted into its ridge; so that this *supinator brevis* is very directly opposed to the *pronator teres*, the insertion of the two muscles almost meeting on the edge of the radius. It is almost circumscribed to one use, that of performing the rotation of the radius outwards; but, perhaps, it may also have some little effect in extending the ulna, and of assisting the *anconeus*.

MUSCLES SEATED ON THE HAND.

BESIDES these muscles which bend and extend the fingers, there are other smaller ones seated on the hand itself, which are chiefly for assisting the former, and for quicker motions; but most especially for the lateral motions of the fingers, and which are named *ADDUCTORS*, *ABDUCTORS*, and *FLEXORS*, when they belong to the thumb and to the little-finger.

That they are chiefly useful in assisting and strengthening the larger muscles, is evident from this, that much power being required for flexion, we find many of these smaller muscles added in the palm of the hand; but as there is little

power of extension needed, no more almost than to balance the power of the flexors, there are no small muscles on the back of the hand, the *interossei externi* excepted, which are chiefly useful in spreading the fingers.

The short muscles in the palm of the hand are for bending the thumb, the fore-finger and the little-finger; and the little-finger and the thumb have each of them three distinct muscles; one to pull the thumb away from the hand, one to bend it, and one to pull it towards the hand, opposing it to the rest of the fingers, and so of the little-finger, which has also three muscles.

ARRANGEMENT OF THESE MUSCLES.

1. LUMBRICALES, which bend the fingers.
2. ABDUCTOR POLLICIS, removing the thumb from the fingers.
3.

{	FLEXOR AND OPPONENS POLLICIS,	}
{	ADDUCTOR POLLICIS,	}

 carrying the thumb towards the palm as in grasping.
4. ABDUCTOR INDICIS, } which carries the fore-finger towards the thumb.
5.

{	ABDUCTOR MINIMI DIGITI,	}
{	ADDUCTOR MINIMI DIGITI,	}
{	FLEXOR MINIMI DIGITI,	}

 which bend the little-finger, and carry it, like the thumb, outwards or inwards.
6. INTEROSSEI } which are small muscles, lying betwixt the metacarpal bones, and assisting the lumbricales in bending the fingers, and perform the lateral motions of the fingers.

All the muscles of the thumb are seated on the inside, to form the great ball of the thumb; and it is not easy at first to conceive how muscles having so much the same place should perform such opposite motions; yet it is easily explained, by the slight variation of their places; for the *ABDUCTOR* arises from the annular ligament near the radius, and goes towards the back of the thumb.

The flexors arise deeper, from the bones of the carpus, and from the inside of the ligament, and go to the inside of the thumb. The *ADDUCTOR* arises from the metacarpal of the mid-finger, and goes to the inner edge of the thumb.

CIII. The *ABDUCTOR POLLICIS* is only covered by the common integuments. It begins a little tendinous from the outside of the annular ligament, just under the thumb, and by some little fibres from the trapezium; and, from the tendon of the long abductor or extensor primus, it bends gradually round the thumb, and is at last inserted in the back of the first joint, just above the head of the metacarpal bone. But it

does not stop here ; for this flat tendon is now expanded into the form of a fascia, which, surrounding the first bone of the thumb, goes forward upon its back part, quite to the end, along with the common tendon of the extensor. This muscle, like the others, is covered by a thin expansion from the tendon of the palmaris, as well as by the common integuments.

Its only use is to pull the thumb from the fingers, and to extend the second bone upon the first.

Albi us describes a second muscle of the same name, having the same course, origin, insertion, and use : it also arises from the outer side of the ligament of the wrist, and is fixed into the side of the thumb, and lies upon the inside of the former muscle.

These two are inserted into the first bone of the thumb ; but the next is inserted into the metacarpal bone.

CIV. The *OPPONENS POLLICIS* is often called the flexor of the metacarpal bone of the thumb. It is placed on the inside, and implanted into the side of the thumb : its office is to draw the thumb across the other fingers, as in clenching the fist ; and from its thus opposing the fingers it has its name of *opponens*.

It lies immediately under the last described muscle, and is like it in all but its insertion.

It arises from the trapezium, and from the ligament of the wrist. It is inserted into the edge and forepart of the metacarpal bone of the thumb ; and its use is to turn the metacarpal bone upon its axis, and to oppose the fingers ; or in other words to bend the thumb : for I can make no distinction. Therefore this muscle and the next, which lies close upon it, may be fairly considered as but two different heads of one thick short muscle.

CV. The *FLEXOR BREVIS POLLICIS* is a two-headed muscle, placed quite on the inside of the thumb, betwixt the forefinger and the thumb, and extends obliquely across the two first metacarpal bones. It is divided into two heads by the long flexor of the thumb.

The edge of this muscle lies in close contact with the edge of the last, or *opponens* ; and indeed they may fairly be considered as one large muscle surrounding the basis of the thumb.

One head arises from the *os trapezium*, or base of the thumb, and from the ligament of the wrist. The other head comes from the *os magnum* and *unciforme*, and from the ligaments which unite the bones of the carpus.

The first head is the smaller one ; it terminates by a pretty considerable tendon in the first sesamoid bone. The second head runs the same course : it is implanted chiefly in the se-

cond sesamoid bone, and also into the edge of the first bone of the thumb close by it. The second head is exceedingly muscular and strong: the heads are completely separated from each other by the tendon of the flexor longus passing betwixt them,

The office of this muscle is to bend the first joint upon the second, and the metacarpal bone upon the carpus: and indeed the office of this, and of the opponens, is the same. It is in the tendons of this double-headed muscle that the sesamoid bones are found.

CVI. The **ADDUCTOR POLLICIS** arises from the metacarpal bone of the middle-finger, where it has a flat extended base. It goes from this directly across the metacarpal bone of the fore-finger to meet the thumb. It is of a triangular shape, and flat: its base is at the metacarpal bone; its apex is at the thumb: it is inserted into the lower part or root of the first phalanx: its edge ranges with the edge of the flexor brevis; it concurs with it in office; and its more peculiar use is to draw the thumb towards the fore-finger, as in pinching.

Thus do these muscles, covering the root of the thumb, form that large ball of flesh which acts so strongly in almost every thing we do with the hand.

The ball of the thumb is fairly surrounded; it is almost one mass, having one office: but as the deltoides will, in some circumstances, pull the arm downwards, some portions of this fleshy mass pull the thumb outwards obliquely; some directly inwards: but the great mass of muscle bends the thumb, and opposes it to the hand: and as this one muscle is to oppose the whole hand, the ball of flesh is very powerful and thick.

The short muscles of the little finger surround its root, just as those of the thumb surround its ball.

CVII. The **ADDUCTOR MINIMI DIGITI** is a thin fleshy muscle, which forms the cushion on the lower edge of the hand, just under the little finger. It is an external muscle: it arises from the os pisiform, and metacarpal bone of the little-finger, and from the outer end of the annular ligament. It is inserted laterally into the first bone of the little-finger; but a production of it still goes forward to the second bone of the little-finger.

Its use is to spread the little-finger sideways, and perhaps to assist the flexors.

CVIII. The **FLEXOR PARVUS MINIMI DIGITI** is a small thin muscle which rises by the side of the last, and runs the same course, with nearly the same insertion.

Its origin is from the ligament of the wrist, and in part from the crooked process of the unciforme bone. Its use is to bend the little-finger. And indeed the office and place of both is

so much the same, that I have marked the last as a flexor ; the little difference there is, is only that this performs a more direct flexion.

CIX. The *ADDUCTOR MINIMI DIGITI* is sometimes called the metacarpal of the little-finger. It lies immediately under the former muscle. Its origin is from the hook of the unciforme bone, and the adjoining part of the carpal ligament.

It is inserted into the outside of the metacarpal bone which it reaches by turning round it. Its use is to put the little finger antagonist to the others : it is to this finger what the opponens is to the thumb. It also, by thus bending one bone of the metacarpus, affects the whole, increases the hollow and external convexity of the carpus, and forms what is called Diogenes' cup.

CX. The *ABDUCTOR INDICIS* is a flat muscle of considerable breadth, lying behind the adductor pollicis, and exactly resembling it, being like the second layer. It arises from the os trapezium, and from the first bone of the thumb ; and it is inserted into the back part of the first bone of the fore-finger, and pulls it towards the thumb.

The *INTEROSSEI* are situated betwixt the metacarpal bones. They are small, round, and neat, something like the lumbricales in shape and size, and in office resemble the adductors and abductors. Four are found in the palm which bend the fingers and draw their edges a little towards the thumb ; three are found on the back of the hand, for extending the fingers ; they at the same time perform the lateral motions of the fingers.

CXI. The *INTEROSSEI INTERNI* arise from betwixt the metacarpal bones. They are also attached to the sides of these bones. They send their tendons twisting round the sides to the backs of these bones. And they are inserted along with the tendons of the lumbricales and extensors, into the back of the finger. They are thus flexors of the first joint, and extensors of the second joint, as the lumbricales are.

CXII. The *INTEROSSEI EXTERNI* are three in number.—They arise, like the interni, from the metacarpal bones and their interstices, and from the ligaments of the carpal bones. They are peculiar in having each two heads, therefore named *interossei bicipites*. They join their tendons to those of the extensor and lumbricales : they have therefore one common office with them, that is, extending all the joints of the fingers. Many have chosen to describe the origin and insertion with most particular care, marking the degree of obliquity, and ascertaining precisely their office, and giving particular names to each, as *prior indicis* for the first external ; all which I

forbear mentioning, because they must be more liable to perplex than assist: if we but remember their common place and office, it is enough. The tendons of the flexor muscles bend round the finger, along with the interossei and lumbricales, for a surer hold; consequently the tendons of the lumbricales, of the interossei interni, of the extensors, and of the interossei externi, meet upon the backs of the fingers, which are by them covered with a very strong web of tendinous fibres.

CHAP. IV.

MUSCLES OF RESPIRATION; OR, OF THE RIBS.

THE whole back is clothed with strong muscles, and all its holes, irregularities, and spines, are crossed with many smaller ones. These muscles are related either to the arm, to the ribs, or to the spine, (*i. e.*) the vertebræ, whose motions they perform; and from this we obtain an arrangement not inconsistent with the regular order of their office, and yet corresponding with the best order of dissection.

The first or uppermost layer of muscles, viz. the trapezius, the musculus patientiæ, the rhomboides, the latissimus dorsi, belong to the arm. The serrated muscles which lie next under these, are the muscles of respiration, and belong to the ribs; while the splenius and complexus, the muscles of the neck, the longissimus dorsi, sacro-lumbalis, and the quadratus lumborum, which are muscles of the back, and the innumerable smaller muscles which lie betwixt the vertebræ, belong entirely to the spine.

Respiration is indeed performed chiefly by the muscles of the belly, that is, in ordinary and easy breathing. In high breathing, the difficulty is relieved by the co-operation of almost all the muscles of the trunk, of which there is scarcely one that may not assist in some slight degree. But yet the muscles of the abdomen have many other offices. And the muscles of the spine, and of the scapula, again belong properly to the arm and trunk, and therefore I call those the muscles of respiration, by which the ribs are moved in

breathing, and which have no direct relation to almost any other motion, but merely that of the ribs.

The muscles which are appropriated to the ribs, performing no other motions, are,

1. The **SERRATUS POSTICUS SUPERIOR**, { which comes from the neck, and lies fleshy over the ribs, to pull them upwards.
2. The **SERRATUS INFERIOR POSTICUS**, { which comes from the lumbar vertebræ, and lies flat on the lower part of the back, to pull the ribs downwards.
3. The **LEVATORES COSTARUM**, { which are twelve flat muscles arising from the transverse process of each vertebra, and going down to the rib below, they raise the ribs.
4. The **INTERCOSTAL MUSCLES**, { which lie betwixt the ribs, and fill up all the space betwixt rib and rib; they also raise the ribs.

And there may be added to these, that muscle, which, lying under the sterni, and within the thorax, is called *triangularis sterni*, and pulls the ribs downwards.

CXIII. The **SERRATUS SUPERIOR POSTICUS** lies flat upon the side of the neck, under the trapezius and rhomboides, and over the splenius and complexus muscles. It arises by a flat and shining tendon from the spines of the three lower vertebræ of the neck and the two uppermost of the back. It goes obliquely downwards under the upper corner of the scapula, and is inserted into the second, third, fourth, and fifth ribs, by three or four neat fleshy tongues.

The *ligamentum nuchæ* is chiefly formed by the meeting of the *trapezii* muscles; but the flat tendons of these upper serrated muscles help to form it.

They are purely levators of the ribs; their effect upon the vertebræ, if they have any, must be very slight.

CXIV. The **SERRATUS INFERIOR POSTICUS** is a very broad thin muscle, situated at the lower part of the back, under the *latissimus dorsi*, or over the *longissimus dorsi* muscle.

It arises in common with the *latissimus dorsi*, from the spines of the two lower vertebræ of the back, and the three uppermost vertebræ of the loins. Their origin, like that of the *latissimus*, is by a thin tendinous expansion; it soon becomes fleshy, and, dividing into three, sometimes four fleshy strips of tongues, each of them is inserted separately into the

ninth, tenth, eleventh, twelfth lower ribs, near their cartilages. So that this muscle, spreading so wide out from the centre of motion, has vast power ; for it has the whole length of the rib as a lever.

The office of it is to pull the ribs downwards and backwards, the effect of which must be to compress the chest, and in certain circumstances to turn the spine.

CXV. The *LEVATORES COSTARUM* are twelve muscles on each side, for the direct purpose of raising the ribs, they lie above or upon the ribs, at their angles, and are thence named, by some *SUPRA COSTALES*.

They are almost a portion of the external intercostal muscles. The first of the levators arises from the transverse process of the last vertebra of the neck, and goes down to be inserted into the first rib, near its tuberosity ; and so all that follow arise from a transverse process, and go to the rib below, being very small and tendinous at either end ; but the three last levators arise from the second process above the rib to which they belong : they pass one rib to go into the one below it ; they are consequently twice as long as the nine first are, and are therefore named *LEVATORES COSTARUM LONGIORES*, from the ninth downwards.

Thus, the levators costarum are a succession of small muscles, arising from the transverse processes of the vertebræ, and going to the angles of the ribs, beginning from the last vertebra of the neck, and ending with the last but one of the back. They lie under the *longissimus dorsi*, and *sacro-lumbalis* ; and often they have connexions with these muscles, sometimes very close.

CXVI. The *INTERCOSTALES externi* run obliquely from the lower edge of one rib, downward and forward, or in a direction from behind forward, to be inserted into the upper edge of the rib below ; the muscle is not continued into the space betwixt the cartilages of the ribs. The internal, again are perfect betwixt the cartilages of the ribs, but they proceed no further back than the angles of the ribs. They are further different from the internal muscles, inasmuch as they pass obliquely backward and downward from the margin of the one rib to the other.

These two rows were thought to antagonize each other ; the one to pull the ribs downwards, the other to raise them ; but I shall not stop to explain this, nor to refute it ; it is sufficient to declare their true use, which is (both external and internal) to raise the ribs and assist inspiration.*

* I remember many years ago to have heard Dr. Monro explain the office of the intercostal muscles by a diagram, deducing from that argument, the more powerful effect of all muscles having oblique fibres.

The ninth, tenth, eleventh, and twelfth ribs, have a freer motion; and it appears to me that this is the true use of the levatores longiores; and for the same reason, we find, that from the sixth rib and downwards, there are certain slips of the internal intercostals, which pass over one rib, and go to the second below; and as the levatores longiores were called *supracostales*, these have been named *INFRA COSTALES*, and *COSTARUM DEPRESSORES PROPRII*. They were discovered by Verhein, and bear his name; they were explained as depressors of the ribs by Haller, but they are little different from the intercostals in form, and not at all in office, for they raise the ribs, along with the intercostal muscles.

CXVII. The *TRIANGULARIS STERNI*, or *STERNO COSTALIS* is a depressor of the ribs; an internal muscle lying chiefly on the inner face of the sternum, and the cartilages of the ribs. It is very generally considered as a triangular muscle on each side, but some consider it as three or four muscles, under the title of *sterno-costales*.

There are generally four slips lying on the cartilages of the third, fourth, fifth, and sixth ribs. The lower portion of the *triangularis* arises from the ensiform cartilage, and is inserted into the third or fourth rib; the third arises from the middle of the sternum, and goes off from the edges of that bone, to be inserted into the third rib.

The fourth or uppermost portion is often wanting; it goes off in part, also, from the inner surface of the sternum, but more commonly from the third rib, and goes to the second rib.

In a dog they are much longer than in a man. Their office is to depress the ribs; and these portions are all conjoined at their roots, which gives the whole muscle the triangular shape.

The true uses of the *intercostales*, *subcostales*, and *triangularis sterni*, have been disputed; but if the first rib be more fixed than the other ribs, then the *intercostals*, proceeding downwards, from the first rib, must raise all the thorax; and if the sternum be more fixed than the ribs, then the *sterno-costales* muscles going upwards from the sternum, must pull down the ribs.

CHAP. V.

MUSCLES OF THE HEAD, NECK, AND TRUNK.

THE serratus superior posticus being raised, the splenii comes into view, and the splenii being also lifted, the complexus is fully exposed.

CXVIII. SPLENIUS.—The two splenii are so named from their lying like surgical splints, along the side of the neck; both together they have the appearance of the letter Y; the complexus being seen betwixt them in the upper part of the angle. They lie immediately under the trapezii, and above the complexi.

Each splenius is a flat and broad muscle, which arises from the spinous processes of the neck and back, and is implanted into the back part of the head. It arises from the four upper spines of the back, and the five lower of the neck; it parts from its fellow at the fifth vertebra of the neck, so as to show in the interstice two or three of the uppermost spines of the neck, with the upper part of the complexus muscle; each splenius goes obliquely outwards to be inserted into the occipital ridge, and all along to the root of the mastoid process. At the third vertebra of the neck, where the two splenii muscles part from each other, the tendons of the opposite splenii are closely connected both with each other and with the common tendon, which is called ligamentum nuchæ.

This is the **SPLENIUS CAPITIS**; but there is a portion of this same muscle which lies under this, and which has the same common origin, but which terminates by four or five distinct tendons in the transverse processes of the upper vertebræ of the neck. This portion may be dissected apart, and has been considered by many as a muscle, the **SPLENIUS COLLI** of Albinus; who has distinguished as splenius capitis all that part arising from the spines of the neck, and implanted into the head; and as the splenius colli, all that part which arises from the vertebræ of the back, and is implanted into the transverse processes of the neck.

These splenii are the right antagonists of the mastoid muscles; both the splenii acting, pull the head directly backward; one acting turns the head and neck obliquely to one side; one acting along with the corresponding mastoid muscle, lays the ear down upon the shoulder.

CXIX. The **COMPLEXUS** is named from the intricacy of its

muscular and tendinous parts which are mixed ; from the irregularity of its origins, which are very wide, it has the names of *COMPLEXUS IMPLICATUS TRIGEMINUS*, by which the student is warned by the difficulty of understanding this muscle.

It lies immediately under the *splenius* ; arises by distinct tendons, with ten or more tendinous feet from the four lower transverse processes of the vertebræ of the neck, and from the seven uppermost of the back ; having also some less regular origins as from two spines of the back and from four oblique processes in the neck. It grows into a large muscle, which is not like the *splenius*, flat and regular, but thick, fleshy, composed of tendon and flesh mixed, filling up the hollow, by the sides of the spines of the neck, and terminating in a broad fleshy head, which is fixed under the ridge of the occipital bone : and this is the part which is seen in the angle or forking of the *splenii*.

This may stand as the general description of the muscle considered as one. But *Albinus* has chosen to describe it as two muscles, under two different names, with a minuteness which, far from clearing the demonstration of any difficulties, makes it less distinct ; and if any thing could complete the confusion, it was his humour of calling that *BIVENTER*, which had been hitherto named *COMPLEXUS*, and naming the lower part of the muscle *COMPLEXUS*, though it never had been distinguished from the rest.

The *BIVENTER* of *ALBINUS* is the upper layer of the muscle, that part which appears in the fork of the *splenii* : and if we have hitherto named it *complexus*, from its mixture of tendons and flesh, it was particularly improper to transfer that name to another part of the muscle which is less complicated. This upper layer, the *BIVENTER CERVICIS*, is attached by a larger broad head to the occipital bone ; in the centre of this belly there is a confusion of tendon ; then there is a middle tendon about the middle of the arch of the neck, and the lower part of the *biventer* arises from two parts ; first by one slip of flesh from the two uppermost spines of the back ; and, secondly, by a larger fleshy portion which comes from the fourth, fifth, sixth, and seventh transverse processes of the back. And it is from the upper and lower fleshy heads and the confused middle tendon that it is called *biventer*.

The *COMPLEXUS* of *ALBINUS* lies below this one. It arises by three tendinous and fleshy slips, from the three upper transverse processes of the back. Then it has four other slips from four oblique or articulating processes of the neck ; which various origins are gathered into one thick irregular fleshy belly which is implanted into the occiput under the great head of

the biventer, and mixed with it. This I have chosen to explain, lest the student should be embarrassed by false names; referring him to the first paragraph for the true and simple description of this muscle.

CXX. TRACHELO-MASTOIDEUS.*—The last muscle is often named **COMPLEXUS MAJOR**, and this **COMPLEXUS MINOR**; but a fitter name is the **TRACHELO-MASTOIDEUS**, from its origin in the neck, and its insertion in the mastoid process.

Its origin is from the three first vertebræ of the back, and from the five lowest of the neck at their transverse processes. Its origins are by distinct tendons, and its belly is in some degree mixed of tendon and flesh, whence its name of **complexus minor**. It is inserted into the mastoid process just under the insertion of the occipital part of the splenius; and indeed its long and flat belly lies all along under that muscle, so that the order of dissection is this: 1. The **TRAPEZIUS**. 2. The **SPLЕНИUS CAPITIS**. 3. The **SPLЕНИUS CERVICIS**. 4. The **TRACHELO-MASTOIDEUS**.

It is needless to speak of its use, since the use of all these muscles is to draw the head backwards directly, when both act; obliquely, when one acts alone.

The **RECTI MUSCLES** are two deep-seated muscles, which go immediately from the vertebræ to the occiput, to be inserted into its lower ridge. They are called major and minor.

CXXI. The **RECTUS MINOR** is the shorter of the two, arising from the first vertebræ of the neck. Its place of origin is a small tuber which stands in the place of the spinous process of the first vertebra, and from that point, where it is tendinous, it goes up to the occipital ridge, and is inserted fleshy.

CXXII. The **RECTUS MAJOR** is larger. It arises, in like manner tendinous, from the second vertebra of the neck at its spinous process, and mounting from that, is inserted fleshy into the lower ridge of the occiput without the former. These are so placed that the recti minores appear in the interstice of the recti majores. And though we call them both recti, yet they cannot truly be so; for the recti minores must be, in some degree, oblique; and the recti majores still more so; and consequently, although their chief use be conjointly to draw the head directly backwards, yet one acting must turn the head to its side. And indeed the same may be said of all the muscles of the neck.

The **OBLIQUUS SUPERIOR** and **OBLIQUUS INFERIOR**, correspond very closely in all things with the recti; but, in their

* It is the **TRACHELO-MASTOIDEUS**, the **MASTOIDEUS LATERALIS**, the **CAPITIS PARTIUS**, the **COMPLEX MINOR**: by some it is considered as a part of the **COMPLEXUS**.

oblique direction the uppermost, as being much shorter, has been named *obliquus minor*, the lower one *obliquus major*.

CXXIII. The *OBLIQUUS SUPERIOR* arises from the transverse process of the atlas, and is inserted into the end of the lower occipital ridge. Its use notwithstanding its oblique position, is not to turn, but to bend the head backwards, for the occipital condyles standing obliquely, do not permit the rotatory motion of the head on the first vertebra. Its insertion into the occiput is under the splenius and complexus; but one edge of it is above the insertion of the *rectus major*.

CXXIV. The *OBLIQUUS INFERIOR* rises from one vertebra and goes to another. It arises from the spine of the second vertebra: it goes to the transverse process of the first, and it meets the superior oblique muscle; and this one obtains great power, by the lateral projection of the atlas giving it a lever power. The first vertebra or atlas rolls on the tooth-like process of the *dentatus*; and while the great and slow motions of the neck in general are performed by other muscles, there is a presumption, that the short and quick turnings of the head are performed by these oblique muscles.

MUSCLES OF THE TRUNK.

THE great muscles which move the back and loins are the *QUADRATUS LUMBORUM*, *SACRO-LUMBALIS*, and *LONGISSIMUS DORSI*.

The *sacro-lumbales* and *longissimus dorsi* run by the side of the spine, and lie immediately under the *latissimus dorsi*, which is the outer layer; the *quadratus lumborum* lies again under these, and next to the abdominal cavity. Although the *quadratus lumborum* lies deep under the *longissimus dorsi* muscle, I shall describe it first for the sake of a connexion which will be presently understood.

CXXV. The *QUADRATUS LUMBORUM* is a flat squared muscle named *quadratus* from its square, or rather oblong form. It arises fleshy from two or three inches of the back part of the *os ilium*, and from the ligaments of the pelvis, which tie the back part of the ilium to the side of the sacrum, and to the transverse processes of the loins. As it goes upwards along the side of the lumbar vertebrae, it takes hold of the points of the transverse processes of each, by small tendinous slips; so that we are almost at a loss whether to consider these as new origins or as insertions; but its chief insertion is into the lower edge of the last rib, and a small production of it slips under

the arch of the diaphragm, to be implanted into the body or forepart of the last vertebra of the back.

The *LONGISSIMUS DORSI* and *SACRO-LUMBALIS* have their origin in one common and broad tendon coming from the sacrum, ilium, and loins; the two muscles lie alongside of each other; the longissimus dorsi is nearer the spine, and keeps its tendons closer by the spine. The sacro-lumbalis is farther from the spine, and spreads its tendinous feet broader upon the sides of the thorax: and if one be a little under the other, it is the outer edge of the longissimus dorsi, which is a little under the edge of the lumbar muscle.

The common tendon and muscle (for there is for some way but one muscle) begins thus: it may be said to have two kinds of adhesion; for, first externally it appears a broad, flat, and shining tendon, which arises tendinous from all the spines of the lumbar vertebræ; from the spines of the sacrum, and from the back part of the os ilium. But the inner surface of this broad tendon is strongly fleshy; for it arises fleshy from the back part of the ilium; from the deep hollow betwixt the ilium and sacrum; from the sides of the long spines of the lumbar vertebræ; and from their articulating processes, and the roots of their transverse processes. In short, its origin is all tendinous without, and all fleshy within; and its flesh arises from all that irregular surface which is on either side of the spine betwixt the os ilium and the vertebra of the loins: and thus it continues one strong tendinous and fleshy muscle, filling up all the hollow of the loins. There is an appearance of separation, something like a split in the tendon, which shows in the loins what part of the tendon belongs to each muscle; but it is only in the back that they are fairly divided.

Just opposite to the lowest rib, the longissimus dorsi and sacro lumbalis break off from the common tendon; and the longissimus keeps close by the vertebræ, while the sacro lumbalis is implanted into the ribs.

CXXVI. The *LONGISSIMUS DORSI* is a muscle of the spine. It is not a flat muscle, but round, thick, and firm, filling up all the hollow betwixt the spine and the angle of the ribs. It is of a long form, as its name implies, terminating towards its top almost in a point. It has two distinct sets of feet by which it is inserted; one set of feet more fleshy, but small and neat, go outwards from the side, as it were, of the muscle, to be implanted near the heads of the ribs; the lower ones farther out than the heads of the ribs; the upper ones close to the head, and consequently closer to the spine. These heads are nine or ten in number, corresponding with the nine or ten uppermost ribs. Another set of heads, which are not so well seen as this

set, because they lie more under the muscle, are small, neat and tendinous ; they go in an opposite direction, viz. inwards, and upwards ; keep closer by the spine, and are inserted into the transverse processes of the vertebræ of the back. This set of heads is thirteen in number, implanted into the transverse processes of all the back, and of one vertebra of the neck.

CXXVII. The SACRO-LUMBALIS separates from the longissimus dorsi at the last rib, and is a flatter and less fleshy muscle : its twelve tendons are flatter than those of the longissimus dorsi, and go out wider from the spine. The tendons next to the longissimus dorsi run highest up, and are the longest ; those farthest from the spine, (*i. e.*) farthest out upon the chest, are the shortest. It has a flat tendon for each rib, which takes hold upon the lower edge of the rib. But it has another order of small muscles which mix with it ; for as the longissimus dorsi has a double row of insertion, this has another set of attachment, for there arises from the surface of each rib, at least of the six or seven lowest ribs, a small slip of flesh, which runs into the substance of the sacro-lumbalis, and mixes with it ; and these fleshy slips go by the name of the ADDITAMENTUM AD SACRO-LUMBALIS OR MUSCULI ACCESSORII.

Both these muscles, viz. the longissimus and sacro-lumbalis, terminate in points which reach towards the neck, and under the point of each there lie the roots of two small muscles, which go up to move the neck. Many have referred these slips going up into the neck entirely to the muscles I am now describing, calling one an ascending slip of the longissimus dorsi, and the other a slip of the sacro-lumbalis, while others have described them as distinct muscles, having but slight connexions with the longissimus and sacro-lumbalis. Their proper names are CERVICALIS DESCENDENS, and TRANSVERSALIS COLLI.

CXXVIII. The CERVICALIS DESCENDENS is connected with the sacro-lumbalis muscle ; it cannot be entirely referred to it, for the cervicalis descendens arises as a distinct muscle from the five lower vertebræ of the neck, at their transverse processes, goes downwards very small and slender, to be inserted into the six uppermost ribs, to get at which it slips under the longest tendons of the sacro-lumbalis ; but that the cervicalis descendens does not belong to the sacro-lumbalis may be inferred from its having distinct tendons from six ribs, and from five transverse processes of the neck, and from these tendons being in a direction which does not at all correspond with the heads of the sacro-lumbalis. Indeed the longissimus dorsi has a better claim to this muscle ; for a long slip, partly tendinous and partly fleshy, runs upwards from the longest tendon of the longissimus dorsi, to join itself to the cervicalis descendens, per-

haps it would be better to consider it a continuation of the *accessorii ad sacr. lumbal.**

CXXIX. The **TRANSVERSALIS COLLI** is that which Sabitier refers to the *longissimus dorsi*; but it is a distinct muscle, arising partly tendinous, and partly fleshy, from the five upper-transverse processes of the back; lies betwixt the *trachelo-mastoideus* and the *cervicalis descendens*; goes from the transverse processes of the back to the transverse processes of the neck, and has no more than a confused and irregular connexion with any other muscle.

The **QUADRATUS LUMBORUM** keeps the trunk erect, by the action of both muscles at once; inclines it to one side, or turns it upon its axis, when one only acts; and by its insertion into the ribs, must assist in high breathing, by pulling down the ribs. The **LONGISSIMUS DORSI** has no power but over the spine, which it bends backwards, acting continually in keeping the trunk erect. This is also the chief use of the *sacro-lumbalis*; but the **SACRO-LUMBALIS** going out further upon the ribs, takes such hold upon them, that besides its common action of raising the trunk, it may, on occasions, pull them down, assisting the *quadratus* and the lower serrated muscle. And it will have greater power in turning the trunk of the body upon its axis than the *longissimus dorsi* which pulls almost directly backwards. The **CERVICALIS DESCENDENS** co-operates with the *trachelo-mastoideus*, and others, which turn the head to one side; and the *cervicalis descendens* bends the neck to one side, both the one and the other being independent muscles.

These two muscles bring us to mention that intricate set of muscles which fills up all the hollows and interstices among the spines and irregular processes of the *vertebræ*, which might be fairly reckoned as one muscle, since they are one in place and in office, but which the anatomist may separate into an infinite number, with various and perplexing names: an opportunity which anatomists have been careful not to lose.

The surface of the back, from the bulge of the ribs on one side, to the bulge of the ribs on the opposite side of the thorax, is one confused surface, consisting of innumerable hollows, processes, and points of bone; and it is tied from point to point with innumerable small muscles, or unequal bundles of mixed tendon and flesh. There are many points,

* Hence it is plain that the *sacro-lumbalis* and *longissimus dorsi* have nearly an equal claim to this *cervicalis descendens*. For, first, the *longissimus dorsi* sends its longest tendon fairly up into the *cervicalis descendens*, so far, that the slip is implanted into the transverse processes of the neck. And, secondly, the feet of the *cervicalis descendens* begin under the last tendons of the *sacro-lumbalis*, so as to have the appearance of arising from its supplementary muscle, the *additamentum*, and being a part of it; and indeed Sabitier has described it according to this view.

as the spinous, transverse, and oblique processes of the vertebræ, and the bulging heads and angles of the ribs; and each process, or at least each set of processes, has its distinct sets of muscles and tendons.

1. There is one long continuity of muscular and tendinous fibres going from spine to spine, and lying on the side of the spinous processes along the whole length of the back and neck. This is divided into the *SPINALIS CERVICIS*, and the *SPINALIS DORSI*.

2. There is a similar continuation of fibres, with less tendon and more flesh, belonging one half to the spinous, and the other half to the transverse processes, whence it is named *SEMI-SPINALIS DORSI*.

3. There is a great mass lying all along the hollow of the back, on each side of the spinous processes, which passing alternately from the transverse process of one vertebra to the spinous process of the next above, is of course split into many heads, but yet having such connexion as to give it the form and name of a single muscle, the *MULTIFIDUS SPINÆ*.

4. and 5. There are yet smaller muscular fasciculi which stand perpendicularly betwixt every two transverse and every two spinous processes; thence they are named *INTER TRANSVERSARI* and *INTER-SPINALES*.

CXXX. The *SPINALIS CERVICIS* is that which is implanted into the spines of the cervical vertebræ: but because it does not go from spine to spine, like the *spinalis dorsi*, but from transverse processes to spines, it has been named by Winslow, *SEMI-SPINALIS*, or *TRANSVERSO-SPINALIS COLLI*. It arises from the transverse processes of the six upper vertebræ of the back, and is inserted into all the spinous process of the vertebræ of the neck, except the first and last; and it extends the neck, or by its obliquity may contribute to the turnings of the neck, or to bending it to one side.*

CXXXI. The *SPINALIS DORSI* arises from two spinous processes of the loins, and from the three lower spines of the back, and passing two spines untouched, it is implanted into all the spines of the back, except the uppermost. This muscle is very slender and long, and consists fully more of tendon than of flesh; it has five feet below, rising from the lower spines of the back and loins: and nine feet above, implanted into the upper spines of the back. Its action must raise the spine, but perhaps it may be equally useful, as a muscular and tendinous ligament.

* The *TRANSVERSALIS CERVICIS* (vide p. 214.) is that which goes from the transverse processes of the back to the transverse processes of the neck; while this, the *SPINALIS CERVICIS*, goes from the transverse processes of the back to the spines of the neck.

XXXII. The SEMI-SPINALIS DORSI arises from the transverse processes of the seventh, eighth, ninth, and tenth vertebræ of the back, and is implanted into the six or seven upper dorsal spinous processes and into the two last of the neck.*

CXXXIII. The MULTIFIDUS SPINÆ runs from the sacrum along all the spine to the vertebræ of the neck; and is a comprehensive and true way of describing many irregular portions of flesh, which authors have divided into distinct muscles.† It is a continued fleshy indentation, from transverse process to spine, through all the vertebræ of the back, neck, and loins.

It begins both tendinous and fleshy, from the upper convex surface of the os sacrum, which is rough with spines, from the adjoining part of the illium; and in the loins, it arises from oblique processes; in the back, from transverse processes; and again from oblique processes, among the cervical vertebræ.

Its origin in the loins, is close to the spine; being from the upper oblique processes, and from the root of the transverse processes. In the back it arises from the transverse processes and therefore arises there by more distinct heads. In the neck again, it arises from the lower oblique processes, more confusedly.

Its bundles or fasciculi are inserted into the spinous processes, sometimes into the second, or even into the third or fourth spine, above that from which the bundles arises; for the tendons do not stop at that spinous process which they first touch, but go upwards, taking attachments to other two or three, and mixing their tendons with those of the fasciculi, above and below; and these tendons reach from the first of the loins to all the vertebræ up to the atlas, which is the only one not included.

The use of the multifidus spinæ, is to retain the spine from being too much bent forward; for these muscles serve (as I have observed) the purpose of a ligament, and the best of all ligaments, having a degree of strength, exactly proportioned to the necessity for strength. It also moves the spine backwards, though perhaps it is less useful in this than as a ligament; for we find it as strong in the vertebræ of the back, which have little motion betwixt the individual bones, and what little there is, must consequently be general. It

* This is of course the TRANSVERSO SPINALIS DORSI of Winslow.

† TRANSVERSO-SPINALIS LUMBORUM, SACER; SEMI-SPINALIS INTERNUS, sive TRANSVERSO-SPINALIS DORSI, SEMI-SPINALIS, sive TRANSVERSO-SPINALIS COLLI, pars interna.—Winslow. TRANSVERSALIS LUMBORUM, vulgo SACER. TRANSVERSALIS DORSI. TRANSVERSALIS COLLI.

seems rather intended to moderate the lateral motions of the vertebræ than to produce them; when it acts, its chief use is either to resist the spine being bent forward by a weight, or to erect the spine.

CXXXIV. The INTER-SPINALES COLLI, DORSI, and LUMBORUM, have varieties, so little interesting, that they need hardly be described. The INTER-SPINALES COLLI are stronger, because the neck has many and quick motions, and the bifurcated spines of the neck give broader surfaces for these muscles. The INTER-SPINALES DORSI are almost entirely wanting, because the spines of the back are close upon each other, and the vertebræ are almost fixed. The INTER-SPINALES in the LOINS, are rather tendons or ligaments, than proper muscles.

CXXXV. The INTER-TRANSVERSALES are again stronger and fuller in the neck, because of the lateral motions of the neck being free, and its transverse processes forked. They are in more numerous bundles, where the motion is greatest, viz. betwixt the atlas and dentatus; and it is there, that Albinus counts his INTER-TRANSVERSALIS CERVICIS, PRIORES LATERALES, &c. The inter-transversarii are wanting in the BACK, giving place to the ligaments, by which they are tied to each other and to the ribs; but in the LOINS, the inter-transversarii are again strong, for the lateral or twisting motions of the loins.

The muscles on the forepart of the head and neck will complete the catalogue of those belonging to the spine, and they are the chief antagonists to the muscles which I have been describing.

CXXXVI. The PLATYSMA-MYOIDES* is a very thin muscular expansion, like the cutaneous muscle in animals. It is spread over the other muscles, immediately under the skin, and covers the whole neck and lower part of the face.

It arises from the cellular substance and aponeurosis, which cover the pectoral muscle, the deltoid muscle, and the clavicle. Its origin is by long separate fleshy slips; it goes like a thin integument over the neck, and is first inserted about the depressor anguli oris, and then going over the masseter, is lost betwixt the muscles and the integuments of the cheek.

Perhaps it serves also to pull down the skin of the cheek, and the angle of the mouth; but its chief insertion is into the lower jaw, and its use is partly to pull it downwards, but principally to act as a fascia, binding the parts in the neck, and in

* The PLATYSMA-MYOIDES is also named MUSCULUS CUTANEUS LATISSIMUS COLLI.
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violent respiration to press down the blood contained in the great veins of the neck.

CXXXVII. MASTOIDEUS.—This muscle arises partly from the clavicle, partly from the sternum. Albinus reckons it two muscles; the **STERNO-MASTOIDEUS**, and **CLEIDO-MASTOIDEUS**; a more common name is the **STERNO-CLEIDO MASTOIDEUS**, but here, as in other things, I adhere to what is plainest. And the most familiar and easy name is **MUSCULUS MASTOIDEUS**, considering the clavicular portion, as an addition only.

Its origin, from the upper part of the sternum, is pretty round. It arises again flat from the forepart of the clavicle; and this second origin is broad and fleshy, while the first one is tendinous and pointed. These two heads form together a very big strong-bellied fleshy muscle, which is inserted into the mastoid process by a broad tendon, which indeed surrounds the mastoid process, and from that extends still backwards, towards the lamboidal suture. When one of the mastoid muscles acts, it turns the head to one side; when both act, they pull the head directly forwards.

CXXXVIII. RECTUS INTERNUS CAPITIS MAJOR.—There are three muscles on each side, lying under the œsophagus, trachea, and great vessels flat upon the forepart of the vertebræ; and this is the first and longest.

Although this is called rectus, it is oblique and runs rather on one side; for it arises from the transverse processes of the five lower vertebræ of the neck, and it is inserted into the cuneiform process of the occipital bone, just before the foramen magnum.

CXXXIX. RECTUS INTERNUS MINOR.—This is an exceedingly small muscle. It lies immediately under the **RECTUS MAJOR**: it arises from the forepart of the body of the first vertebræ, the atlas, and going (like the other rectus) obliquely inwards, it is inserted into the occipital bone, near the condyle.

CXL. And the **RECTUS CAPITIS LATERÁLIS** is another small muscle like the former, which arises from the transverse processes of the first vertebra, and is inserted into the side of the cuneiform process of the occipital bone. It lies immediately under the exit of the great jugular vein.

CXLI. LONGUS COLLÆ.—This is the chief of those muscles which lie upon the forepart of the neck; it is very long arising from the flat internal surface of the vertebræ of the back, to go up along those of the neck.

Its origin is first within the thorax, from the three uppermost vertebræ of the back, from the flat part of their bodies, and then from all the transverse processes and bodies of the neck, except the three upper ones. It is inserted tendinous

into the forepart of the second vertebræ of the neck, where the opposite large muscles meet in one point almost.*

All these muscles, which lie thus flat upon the plain surface of the vertebræ of the neck, pull the head and neck directly forwards; or when one acts, they are of use in pulling it towards one side; though I rather suppose this motion is performed by the external muscles chiefly,

CXLII. The SCALENUS I consider as one muscle; for it is one in origin, insertion and office. Its origin is from the whole upper surface of the first rib, from its cartilage backwards, and also from the second rib; and its insertion is into the transverse processes of the vertebræ of the neck. But by its broad origin, and its very long insertion, it gives opportunity for dividing it into several fasciculi; and accordingly it has been so divided; but these divisions are entirely modern, artificial, and unnatural. The ancients considered it as one triangular muscle. Winslow divided it into two, the *primus* and *secundus*; Cowper into three; Douglas into four; and Albinus divides it into five muscles. The ancients called it *calenus*, from its resemblance to the scalen triangle; and the true anatomy is, to consider it as one great triangular muscle, flat, and stretching from the ribs to the neck, closing the thorax above, and giving passage to the nerves and vessels of the arm.

If it were to be described in distinct portions, it would be in three parts. The anterior portion arises from the transverse processes of the fourth, fifth, and sixth vertebræ of the neck, and is inserted into the flat part of the first rib hard by its cartilage. The middle portion from the transverse processes of all the vertebræ of the neck goes to the outer edge of the rib, and extends along all its length. The posterior portion arises from the transverse processes of the fourth, fifth, and sixth vertebræ. It is inserted into the upper edge of the second rib, about an inch or more from its articulation with the spine.

The first head is tendinous and fleshy at its insertion into the rib; but the second and third heads are tendinous, both in their origins and insertions.

The nerves pass in the interstice betwixt the first and second portion.

The office of the scalenus muscle is to pull the neck to one side, or to bend the head and neck forward, when both act; and when the neck is fixed backwards, they may perhaps raise the ribs; for asthmatics are observed to throw the head backwards, in order to raise the chest with greater power.

* The *longus colli* muscle is in part covered by the *rectus major*.

CHAP. VI.

OF THE MUSCLES OF THE ABDOMEN, AND OF THE DIAPHRAGM.

THE abdominal muscles covering the belly, contain the bowels, and take a firm hold upon the pelvis and the trunk. The diaphragm, again, is a moving partition betwixt the thorax and the abdomen; and the diaphragm, pressing down the bowels upon the abdominal muscles enlarges the thorax; and the abdominal muscles re-acting, push the bowels back upon the diaphragm, and compress the thorax. Thus, the alternate yielding and re-action of the abdominal muscles and diaphragm perform breathing, agitate the bowels, promote the circulation, expel the fæces and urine assist the womb in the delivery of the child. And, with all these important uses, the abdominal muscles bend and turn the trunk, and fix it for the stronger actions of the limbs. They steady the body in lifting weights, in bearing loads, in all our more violent exertions they often give way under this double office of breathing, and of straining, along with the rest of the body; and the bowels coming out through their natural openings, or by bursting through the interstices of their fibres, form herniæ of various kinds. Whence the anatomy of these muscles is most interesting to the surgeon.

The muscles of the abdomen are five on each side. 1. The outer oblique muscle, to which the names of *DESCENDENS DECLIVIS* and *MAJOR* are added, because it is the outermost of all the abdominal muscles; because it is the largest, covering all the side of the abdomen with its fleshy belly, and all the forepart of the abdomen with its broad expanded tendon; and it is called *declivis*, or *descendens*, because its fleshy belly begins above, upon the borders of the thorax; and because both its muscular and tendinous fibres, which lie parallel to each other, run obliquely from above downwards and inwards.

2. The *OBLIQUUS INTERNUS* is named from its being within the first, and has the names of *ASCENDENS* vel *MINOR* super-added, because its fleshy belly is smaller than that of the first, arises below, chiefly in the haunch bone, and all its fibres, go from below upwards.

3. The *TRANSVERSALIS* lies under all the others, and next to the cavity of the abdomen, and has but one name which

also is derived from the direction of its fibres running across, or round the abdomen.

4. The RECTUS, so named, because of its running on the forepart of the abdomen, in one straight line from the os pubis to the sternum.

5. The PYRAMIDAL muscle is the only one named from its shape. It is a small, neat, conical muscle, which arises from the os pubis, by a broad basis, and has its apex turned upwards; but it is not always found, for it is only as a supplement to the recti muscles, and as a part of them, whence it has been named MUSCULUS SUCCENTURIATUS, or supplementary muscle.

CXLIII. The EXTERNAL OBLIQUE muscle arises from the ribs, and, like all the others which arise from ribs, is a serrated muscle. It comes from the eight lower ribs, by distinct fleshy tongues, one from each rib. These serræ are mixed with the indentations of the serratus major anticus muscle, which goes off in an opposite direction, and with the origin of the pectoralis major and latissimus dorsi. The origin of the muscle lying broad upon the border of the chest, it is its thickest and most fleshy part, whence its fibres go down all in one direction, parallel with each other, but oblique with respect to the abdomen. Its fleshy belly ceases about the middle of the side. Its flat sheet of tendon goes over the forepart of the belly, till it meets its fellow exactly in the middle, so that one half, or the back part of the abdomen, is covered by its fleshy belly, and the forepart by its tendinous expansion.

The muscle meets its fellow in the middle of the belly; and this meeting forms (along with the other tendons) a white line from the pubes to the sternum, which is named LINEA ALBA. It also, before it reaches the middle, adheres to the flat tendon of the internal oblique. This meeting is about four inches on either side of the linea alba, and is a little inclined to the circular, whence it is named linea semilunaris. And, finally, this muscle is implanted into the spine of the ilium, fleshy about the middle of the ilium, tendinous at the forepart, or spinous process of the ilium, and still tendinous into the whole length of that ligament, which extends from the spine of the ilium to the crest of the pubes.

This is the whole of its insertion, viz. all the length of the linea alba, from the pubes to the sternum, the forepart of the spine of the ilium, and the ligament of Poupert, which though it is commonly thought to be but the tendon of the external oblique reaching from point to point, is, in truth, a

distinct ligament, independent of the tendon, and stronger than it.

CXLIV. OBLIQUUS INTERNUS ABDOMINIS.—The chief part of this muscle arises thick and fleshy from all the circle of the spine of the ilium, with its fibres directed upwards. But, to be accurate, we must describe it as arising from the whole length of the spine of the ilium, from the joining of the ilium and sacrum, from the spines of the sacrum itself, and from the three lower spinous processes of the loins;* and, lastly, it arises from nearly half of the ligament of the thigh, at its end next to the ilium: but still the chief belly is at the iliac spine. From that it spreads upwards in a radiated form; the central fibres only are direct, going across the abdomen to the linea alba; the higher fibres ascend and go towards the sternum, and the lower ones go obliquely downwards to the pubes. Its flat tendon is like that of the external oblique, and it is inserted into the cartilages of the seventh, and all the false ribs, into the ensiform cartilage of the sternum, and into the linea alba, through its whole length, and the os pubis.

CXLV. The TRANSVERSALIS ABDOMINIS forms the internal layer, it runs directly across the belly. It arises fleshy from the inner surface of the seven lower ribs, where its digitations mix with those by which the diaphragm arises; tendinous from the transverse processes of the four lower lumbar vertebræ, and last of the back: from the whole spine of the os ilium internally, and from a part of the femoral ligament. Upon the whole, its origin is like that of the inner oblique muscle; its fibres go across the abdomen, and its tendon is inserted into the whole length of the linea alba, cartilago ensiformis and os pubis.

The succession in which these three muscles arise from the chest, is this: the external oblique muscle lies broad upon the outside of the chest, and so its tongues mix with the tongues of the serratus anticus major. The internal oblique muscle again rises lower down the thorax, from its edge, from the cartilages of the ribs. The transverse muscle arises within the thorax, from the internal surface of the ribs, opposite to where the tongues of the external oblique lie: and the diaphragm arising from the same ribs, mixes its indigitations with the transversalis, so that Gasper Bartholin, observing this indigitation to be very curious in the larger animals, believed the diaphragm and transverse muscles to be but one great trigastric, or three-bellied muscle, surrounding all the

* This origin from the spinous processes of the loins, is a thin tendon, common with the serratus and latissimus dorsi muscles.

abdomen. But the transversalis, with the other abdominal muscles, are the antagonists of the diaphragm.

CXLVI. The **RECTI** muscles cover the abdomen on its forepart, in a line from the pubes to the sternum, and they belong so equally to the sternum and to the os pubis, that it is indifferent which we call their origin, and which their insertion. The origin (as I should call it) of each rectus muscle is in the sternum, is broad and fleshy, lies upon the outside of the sternum, covering part of it, and all the xiphoid cartilage, and touching and mixing its fibres with the great pectoral muscle, and likewise taking part of its origin from the cartilages of three of the ribs. It is about four inches broad all down the abdomen, and terminates at the side of the symphysis pubis, with a flat and pointed tendon about an inch in length and about an inch broad. This muscle is crossed at intervals by four tendinous intersections, which divide it into five distinct bellies. Commonly there are three bellies above the umbilicus, and two below; but the recti muscles are the least regular of all the muscles of the abdomen. Vesalius, Albinus, and Sabbatier, were thought to have found the recti abdominus extending up to the throat. But it is now found that Vesalius had only represented the muscles of a monkey, or of a dog, which are very long, upon the thorax of a human subject. Sabbatier, upon revising his notes, retracts what he had said: and Albinus also is supposed to have seen only a production of the mastoid muscle, extending down the breast; for irregularities of this kind have been found.

CXLVII. The **PYRAMIDAL** muscles are as a supplement to the recti. There is a small neat pyramidal muscle on each side, or rather a triangular muscle, fleshy through its whole extent and length, with its base turned towards the pubes, and its apex towards the umbilicus; so that its origin is in the crest of the pubes, and its pointed insertion in the linea alba: and though the recti muscles have been supposed by Massa to relate to the penis, or by Fallopius, to belong to the urinary bladder, their true use is only to resist the rectus to draw down the sternum, and tighten the linea alba, and so to give greater power to the oblique and transverse muscles. The pyramidalis is so irregular a muscle, that sometimes two are found on one side, and none at all on the other. Sometimes two on each other; sometimes there is but one, and very often they are wanting; the belly of the rectus coming quite down to the pubes.

1. The **LINEA ALBA** is the common meeting of all the thin flat tendons, and therefore we call it their insertion, being the

common point towards which they all act ; it is white, by the gathering of all the colourless tendons.

2. The *LINEA SEMILUNARIS* is a line of the same white appearance, of a circular form, and produced by the meeting of all the tendons, on the edge of the rectus muscle, to form a sheath for it.

3. The *SHEATH* for the *RECTUS MUSCLE* does not admit of so brief a definition as this : it has been commonly supposed to be formed in a very curious manner, chiefly by the broad tendon of the obliquus internus, which being the central muscle, betwixt the two other layers is supposed to have its tendon split into two thin sheets ; that the outermost sheet adheres to the outer oblique muscle, forming the outer part of the sheath, while its inner sheet adheres to the tendon of the transverse muscle, forming the inner part of the sheath ; but this is too intricate, and can hardly be proved by dissection. Cowper expresses his doubts about this doctrine of the tendon of the inner oblique muscle being split into two layers ; and I think the truest description is this, that all the tendons meet and adhere in the semilunar line ; that they immediately part to form this sheath ; that the flat tendons of both the oblique muscles go upon the outer surface of the rectus, to form that side of the sheath ; that the tendon of the transverse muscle only lies under the rectus, forming the lower part of the sheath, and that it is unassisted by any lamella of the inner oblique muscle ; that the sheath is complete at the forepart, or over the muscle ; but that under the muscle the sheath stops about five or six inches above the pubes, and that there the recti muscles (or in their place the pyramidal muscles) lie bare upon the bladder, and other abdominal viscera, lined only by the thin peritonæum.* And that this back layer of the sheath is thinner and more delicate, and but little attached to the back part of the rectus muscle, which is easily raised in dissection, while the forepart of the sheath adheres firmly to the forepart of the muscle, forming those cross bands, or tendinous intersections which divide the rectus into bellies, and the sheath where it lies over the muscle cannot be dissected without a degree of violence, either to the sheath, or to these tendinous intersections.

4. The *UMBILICUS* is that opening in the centre of the abdomen, in the middle of the linea alba, through which the nutritious vessels of the fœtus pass. The vessels have degenerated

* Cowper had never observed this but once, that the lower part of the rectus was not lined by the tendon of the transversalis. He concluded, that in this instance it was a sporting of nature : “so much a *lusus nature*, that accidents like this might be the cause of certain ruptures.”

into ligaments in the adult, and the umbilicus is closed in the form of a ring; but sometimes it is forced by violent action, and the viscera come out by it, forming umbilical hernia.

5. The RING of the ABDOMINAL MUSCLES is that opening near the lower part of the abdomen, just over the pubes, through which the spermatic cord passes in men, and the round ligament of the womb in women.

Cowper (p. 5.) says that the spermatic cord passes through separate rings, in each of the three abdominal muscles; and, like older authors, he makes nature exceedingly wise, in placing the rings not opposite to each other, but one high, and another lower, and a third lower still, so as to prevent the bowels falling out. But the truth is, that neither the internal oblique nor the transverse muscles have any share at all in the ring, which belongs entirely to the external oblique muscle, and is formed in this way: all the tendinous fibres of the external oblique are, like the muscle itself, oblique, running from above downwards; and the tendinous fasciculi are in some places wider, a little disjointed from each other, and resembling stripes, crossed by small threads of tendon, as if the long fibres were in danger of parting from each other, so as to leave a gap, and were held together by these cross threads; and it is in fact a wider and perfect separation of two fibres that forms the ring, and a stronger interlacement of cross fibres, that secures it from splitting farther up. But the chief security of the ring is by the form of the opening; for it is not a ring, as we call it but a mere split in the tendon, which begins about an inch and a half above the pubes, is oblique, and looking towards the pubes, like the fibres which form it, and consists of two legs, or pillars of the ring, as they are called; for the upper slip which forms the upper part of the opening, goes directly towards the crest, or highest point of the pubes; the lower pillar, or the slip which forms the lower line of the slit, turns in behind, gets under the upper one, and is implanted into the pubes, within and behind the upper pillar; this lower slip forms at once the lower pillar of the ring and the edge of the femoral ligament.

Now this crossing of the pillars of the ring secures it; for the more the muscle pulls, in pressing upon the abdomen viscera, the tighter is the slit drawn; and the obliquity of the opening gives the direction to herniæ of the groin, which always point towards the pubes, so as to fall into the scrotum in men, or into the labia pudendi in women, keeping close by the groin.

The spermatic cord, formed of the vessels belonging to the testicle, passes through this ring of the external oblique muscle; but as the internal and oblique transverse muscles form no

share in the ring, the cord passes by their lower edge, but not through them. At the place where the cord passes obliquely under the edge of the internal oblique muscle, it sends a bundle of fleshy fibres down along the cord, which go all along the cord, gradually extend towards the testicle, expanding and growing thin upon the upper end of the testicle, and gradually disappearing on the tunica vaginalis.

CXLVIII. The CREMASTER MUSCLE of the TESTICLE, which is a thin slip of fibres from the internal oblique muscle of the abdomen, which is designed for suspending the testicle, and for drawing it up, is very thick and strong in the lower animals, as in bulls, dogs, &c. ; is easily found in man, but not always, being sometimes thin and pale, and hardly to be known from the coats upon which it lies. It appears to grow more fleshy in old age and to be thickened in enlargements of the testicle the better to support the weight.

6. The LIGAMENT of the THIGH* is a distinct ligament, and not merely the tendon of the external, oblique, rounded and turned in. It arises from the spinus process of the ilium and is inserted into the crest of the pubis. It receives the external oblique muscle, for the tendon is implanted into it. Part of the flesh of the internal oblique muscles arise from the outer end of the ligament. It forms an arch over the psoas and iliacus internus muscles, where the great artery of the thigh, and its anterior nerve pass out, and it is tied down at both sides of the passage for the vessels by the fascia of the thigh. The great vein and the lymphatics of the limb, return under it to get into the abdomen ; the lymphatic glands of the groin lie here ; the whole interstice is surrounded and filled up by cellular substance and fat, but it is not firm ; the playing of the muscles and the fat, and inguinal glands, keep it open and lax ; and the bowels are apt to fall down here, especially in women, where the point of the ilium is high, and the arch wide.

It often happens, that in vomiting, in violent coughing, in straining at stool, or in lifting heavy weights, the natural openings are forced, and the bowels descend. The UMBILICUS is very seldom forced by sudden exertion, for it is a very firm ring ; but it is slowly dilated in pregnancy, and hernia of the navel is infinitely more frequent with women than with men. The opening of the RING is often kept dilated by the bowels following the testicle when it descends ; forming the congenital hernia ; most frequently of all, the ring is forced in strong young men by hard and continued labour or by sudden strain-

* This ligament of the thigh is named also the **INGUINAL LIGAMENT** ; the **CRURAL ARCH** ; the **LIGAMENT of PAUPART** ; the **LIGAMENT of FALLOPIUS**, &c.

ing; but women are safer from this kind of hernia, because the round ligament of the womb is smaller than the spermatic cord, and the ring in them is very close.—ABDOMINAL HERNIÆ are those which come not through any natural opening, but through the interstices of the muscles, or their tendons; sometimes hernia follows a wound of the abdomen; for a wound of the abdominal muscles may not heal so neatly as not to leave some small interstice, through which the bowels protrude. Thus any point may be forced by violence, any of the openings, or all of them, may be relaxed by weakness, as in dropsical or other lingering diseases: for it is from this cause that herniæ are more frequent in childhood and in old age, by the laxity which is natural to childhood, or by the weakness natural to the decline of life. Often there seems to be a hereditary disposition to herniæ in certain houses, the form of the openings of the abdomen being wider in a whole family, just as the features of the face are peculiar. And I have seen a child with all these opening so particularly wide, that upon the slightest coughing or crying, herniæ came down at every possible point at the navel, the scrotum, the thigh, and in the sides of the abdomen, all at once; or as one tumour was reduced, another arose.

The effects of the abdominal muscles in moving the trunk cannot be mistaken. The RECTI pull the ribs downwards in breathing, flattening the belly, and bending the body forwards. The two OBLIQUE MUSCLES of one side acting, turn the trunk upon its axis; but the oblique muscles of the opposite side acting, co-operate with the rectus in flattening the belly, and bending the body; and the TRANSVERSE MUSCLES tighten the linea alba, so as to give effect to all the others; and particularly they brace the sheath of the recti muscles, so as to give them their true effect.

CXLIX. The DIAPHRAGMA is a Greek word, translated inter-septum, the transverse partition betwixt the abdomen and the thorax, the midriff; but it is not merely a transverse partition, it is a vaulted division betwixt the thorax and abdomen; and not only is the middle raised into a vaulted form, but its obliquity is such, that though its forepart be as high as the sternum, its lower and back part arises near the pelvis from the lowest vertebra of the loins.

It is a circular muscle, which is fleshy towards its borders, and tendinous in the centre; which is convex towards the thorax, and concave towards the abdomen; becoming plain, or almost so, when it presses against the abdominal muscles in drawing the breath; and returning to its convex form, when the abdominal muscles re-act in pushing it back into the thorax.

The diaphragm arises, by one broad fleshy attachment from all the borders, of the chest, forming the upper or greater muscle of the diaphragm : and it arises below, by many small tendinous feet from the forepart of the loins, which meeting, form what is called the lesser muscle of the diaphragm. 1st, The GREAT or UPPER muscle arises, first, from under the xiphoid cartilage, and from the lower surface of the sternum. 2dly, From all the false ribs ; from the cartilage of the seventh, eighth, and ninth ribs ; and from the bony parts of the tenth and eleventh ribs, and from the tip of the twelfth rib. All these origins are, of course, fleshy digitations or tongues which intermix with those of the transverse muscle of the abdomen. 3dly, From the tip of the twelfth rib to the lumbar vertebræ, there is a ligament extended, which, going like an arch over the psoas and quadratus lumborum muscles, is named **LIGAMENTUM ARCUATUM** ; and from this another part still of the great muscle of the diaphragm arises. Thus, the upper muscle of the diaphragm has four chief origins, viz. from under the sternum and xiphoid cartilage ; from all the false ribs ; from the ligamentum arcuatum ; and, in short, from all the borders of the chest, from the xiphoid cartilage quite round to the vertebræ of the loins.

2. The LESSER MUSCLE of the DIAPHRAGM, which arises from the spine, begins by four small slender tendinous feet on each side. The first of these, the longest one, arises from the second vertebra above the pelvis : it goes from the flat forepart of its body, and adheres to the forepart of all the lumbar vertebræ as it mounts upwards. The second rises from the third vertebra, but farther out towards the side of the vertebra. The third arises from the side of the fourth vertebra. And the fourth tendon of the diaphragm arises from the transverse process of the same fourth vertebra of the loins. But indeed we ought in place of this minute demonstration, to say that it arises from the four uppermost lumbar vertebræ by four tendinous feet, flat and glistening, and adhering closely to the shining ligament with which the bodies of the vertebræ are strengthened ; that these tendons soon join to form two strong round fleshy legs, which are called the *crura diaphragmatis* ; of which *crura*, the left is the smaller one : and these *crura* having opened to admit the aorta betwixt them, and then joining, mixing, and crossing their fibres, form a fleshy belly, the lesser muscle of the diaphragm.

3. The TENDON in the centre of the diaphragm is determined in its shape by the extent of these fleshy bellies ; for the great muscle above almost surround the central tendon. The smaller muscle below meeting it, the two divisions give it a

pointed form behind ; the tendon has the figure of a trefoil leaf or of the heart painted upon playing cards. The middle line of this tendinous centre is fixed by the membrane which divides the thorax into two ; the two sides go upwards into the two sides of the chest, each with a form like the bottom of an inverted basin : their convexity reaching within the thorax, quite up to the level of the fourth true rib : the proper centre of the diaphragm is fixed by this connexion with the mediastinum, that its motion might not disorder the action of the heart, which rest upon this point, and whose pericardium is fixed to the tendon : but the convexity of either side descends and ascends alternately as the diaphragm contracts or is relaxed ; so that it is chiefly these convexities on either side which are moved in breathing.

Thus is the diaphragm composed of one great and circular muscle before ; of one smaller circular muscle behind ; and of the triangular tendon, as the centre betwixt them : and, both in its fleshy and tendinous parts, it is perforated by several vessels passing reciprocally betwixt the thorax and the abdomen.

First, the AORTA, or great artery of the trunk, passes betwixt the crura or legs of the diaphragm, which, like an arch, strides over it to defend it from pressure. The thoracic duct passes up here also.

Secondly, The ŒSOPHAGUS passes through the diaphragm, a little above this, and to the left side : its passage is through the lower fleshy belly, and through the most fleshy part of the diaphragm : and the muscular fibres of the crura diaphragmatis first cross under the hole for the Œsophagus ; then surround it ; then cross again above the hole ; so that they form the figure of 8 : and the Œsophagus is so apparently compressed by these surrounding fibres, that some anatomists have reckoned this a sort of spincter for the upper orifice of the stomach.

Thirdly, The great VENA CAVA goes up from the abdomen to the heart, through the right side of the diaphragm ; and this hole being of a triangular form, being in the firm tendon, there is no danger of strangulation, or of the blood being impeded in the vein.

The tendon is composed of fibres which come from the various fasciculi of this muscle, meet and cross each other with a confused interlacement, which Albinus has been at much pains to trace, but which Haller reports much more sensibly : “ *Intricaciones variæ et vix dicendæ* ;” irregular and confused, crossing chiefly at the openings, and especially at the vena cava, the triangular form of which seems to be guarded in a most particular way.

The lower surface of the diaphragm is lined with the peri-

tonæum, or membrane of the abdomen ; and the upper surface is covered with the pleura, or membrane of the chest. The hole for the vena cava is so large that the peritonæum and pleura meet, and nearly touch each other through this opening, all round the vein.

The chief use of the diaphragm is in breathing, and in this office it is so perfect, that though there be a complete ankylosis of the ribs (as has often happened,) the person lives and breathes, and never feels the loss. The diaphragm is, in its natural state, convex towards the thorax ; when it acts, it becomes plain, the thorax is enlarged, and, by the mere weight of the air, the lungs are unfolded, and follow the diaphragm. No vacuum is ever found betwixt the diaphragm and the lungs ; but the lungs follow the ribs and diaphragm as closely as if they adhere to them : and indeed when they do adhere, it is not known by any distress. So we draw in the breath, and when the abdominal muscles re-act, the diaphragm yields, goes back into the thorax, and grows convex again, by which we blow out the breath ; and while the diaphragm is acting, the abdominal muscles are relaxed, yield, and are pushed out, and leave the ribs free, to be raised by their levator muscles. And again, when the abdominal muscles re-act, the diaphragm in its turn yields so, that they at once force up the diaphragm, and pull down the borders of the thorax, assisting the serrated muscles which depress the ribs.

There is also in every great function, such a wonderful combination of actions conspiring to one end, as cannot be even enumerated here. But the alternate action and re-action of the abdominal muscles draws in and expels the breath, promotes the circulation, and gently agitates the bowels, while their more violent actions discharge the fæces and urine, and assist the womb ; and vomiting, yawning, coughing, laughing, crying, hiccup, and the rest, are its stronger and irregular actions. The diaphragm might well be named by Haller, "*Nobilissimus post cor musculus.*" And Buffon, who affected the character of anatomist with but little knowledge of the human body, might mistake its central tendon for a nervous centre, the place of all motions, and almost the seat of the soul. For the ancients confounded the names and ideas of tendon and nerve. And, in sickness and oppression, lowness and sighing, in weeping or laughing, in joy or in fear, all our feelings seem to concentrate in this part.

CHAP. VII.

THE MUSCLES OF THE PARTS OF GENERATION,
AND OF THE ANUS, AND PERINÆUM.

THE muscles of the parts of generation follow the division of the abdominal muscles more naturally than any other.

The **ERECTOR PENIS** is a small and slender muscle, which goes over the crus penis, and braces it back to the pubes. The **erectores** are supposed (by pressing the penis against the pubis) to compress the great vein, and so cause erection. The **EJACULATOR SEMINIS** is a muscle which surrounds all the bulb of the urethra, and acts by a sort of subsultus in discharging the last drops of the urine, and in throwing out the semen. And the **TRANSVERSALIS perinæi**, which goes across the perinæum, belongs rather to the anus than to the penis.

The **SPHINCTER ANI** is a circular bundle of fibres, which surrounds the orifice of the anus, and contracts it; and the **levator ani** is a flat thin muscle, which lines the pelvis, surrounds the rectum like a funnel, and being fixed round the margin of the anus, raises it up; and the **COCCYGEUS** is but a part of it, The **DETRUSOR URINÆ** is the muscular coat of the bladder, and the **SPHINCTER VESICÆ** is not easily distinguished from the detrusor urinæ, being but the fibres of it, only thicker and stronger at the lower and narrower part of the bladder.

The penis is composed of two crura, or cavernous bodies, which arise from the branch of each os ischium, which soon meet to form the body of the penis; and of the corpus cavernosum urethræ, which surrounds the urethra, is attached to no bone, but begins just before the circle of the anus, by a bulging, which is called the bulb of the urethra; and the erector penis lies along the crura, to draw them back to the pubes; and the ejaculator surrounds all the bulb, and acts in expelling the semen or the last drops of urine.

CL. The **ERECTOR PENIS** is a delicate and slender muscle, about two inches in length. It lies along the face of the crus penis on each side. And when the crura penis are inflated, the erectors are seen of their proper length and form. The erector of each side rises by a slender tendon from the tuberosity of the os ischium. It goes fleshy, thin, and flat, over the crus penis, like a thin covering. It ends in a delicate and flat tendon upon the crus penis, about two inches up; and the tendon is so thin and delicate, that it is hardly to be distinguished from the membrane of the cavernous body.

The erectors lying thus on the sides of the penis, have been called *COLATERALES PENIS* or *ISCHIO-CAVERNOSI* from their origin in the ischium, and their insertion into the cavernous bodies.

CLI. The *TRANSVERSALIS PERINÆI* is often named *transversalis penis*; but its origin being in the tuberosity of the os ischium, by a delicate tendon, and its insertion into the very backmost point of the bulb of the urethra, where it nearly touches the anus, and where there is a meeting of several muscles, its course is directly across the perinæum, and its relation to the perinæum and anus is very direct and evident, while its relation to the penis is rather doubtful. Often there is a second muscle of the same origin and insertion, running like this, across the perinæum, named *TRANSVERSALIS PERINÆI ALTER*.*

This transverse muscle may by bracing up the bulb to the arch of the pubes, have some effect in stopping the vein on the back of the penis, and so producing erection; but its chief use must be in preventing the anus from being too much protruded in discharging the fæces, and in retracting it when it is already protruded.

CLII. The *EJACULATOR* muscle is not a single muscle, as it is often described. It is manifestly a pair of muscles surrounding the whole of the bulb of the urethra. They arise on each side from the side of the bulb, and crus of the penis, and from the triangular ligament of the urethra. From their arising from this ligament, they have been frequently described as arising from the ramus of the pubes. There is along the lower face of the bulb a white and tendinous line, corresponding with the outward line or seam of the perinæum. This line distinguishes the bellies of the two muscles, and is formed by their tendinous insertions; or sometimes this central line is considered as the origin of the muscle: in that case, the fibres of each side surround their proper half of the bulb with circular fibres, winding obliquely round the bulb; and each muscle ends in its separate tendon, which is delicate and small, and which leaving the bulb of the urethra, turns off obliquely to the side, so that the tendon of each side goes out flat and thin

* There is great irregularity in this muscle. There is very frequently a slip called *transversalis alter*, which, however, would be better named *obliquus*. In some bodies the *transversalis* is hardly perceptible, while in others it is very strong: there is also a great variety in the size of it on comparing the two sides of the same body; thus we see frequently in Lascars and Negroes, that on one side there is a very large muscle, while on the other there is a small *transversalis*, and a large *obliquus*.

We may also frequently see a muscle, the *transversalis profundus*; it has exactly the same origin and insertion with the other, but lies deeper. At first view it appears to be part of the *levator ani*, but the fibres run directly across, while those of the *levator* run in a descending direction.

upon the crus penis of its own side, a little higher than the insertion of the erector penis. We know and feel its convulsive, involuntary action in throwing out the seed ; and we are conscious that we use it as a voluntary muscle in emptying the urethra of the last drops of urine.

CLIII. The *SPHINCTER ANI* muscle is a broad circular band of fibres, which surrounds the anus. It arises from the point of the os coccygis behind. It sends a neat small slip forwards, by which it is attached to the back part of the ejaculator muscle ; but the great mass of the muscle is inserted into the common angle of the union of the ejaculator, transversales, and this muscle. It is of a regular oval form, and is, for a very obvious reason, stronger in man than in animals. Some choose to enumerate two sphincter muscles, of which this is the external, or cutaneous ; and what they describe as the internal one, is merely the circular fibres, or muscular coat of the intestine, strengthened a little towards the anus, but not a distinct muscle. Its effect is to shut the anus.

CLIV. The *LEVATOR ANI* muscle is described as a pair of muscles, one from each side ; but it is properly one broad and thin muscle, which arises from the internal surface of all the forepart of the pelvis, and from its breadth, it has been named *MUSCULUS ANI LATUS*. It continues its origin from the internal surface of the pubes, from the edge of the foramen thyroideum, from the thin tendinous sheath that covers the obturator internus and coccygeus muscles, and from the body and spine of the os ischian. It grows gradually smaller, as it goes downward to surround the anus. So it is inserted into the circle of the anus, into the point of the os coccygis, and is mixed with the spincter ani muscle. The whole pelvis is lined with it like a funnel, or inverted cone, the wider part representing its origin from the pelvis, the narrower part its insertion into the anus. The whole bladder is surrounded, and covered by this muscle ; the urethra passes through a split in its fibres, and no operation of lithotomy can reach the bladder from below, without cutting through this muscle. It raises the anus, and at the same time dilates it, opening the anus for the passage of the fæces, and supporting it, so as to prevent its being protruded. Thus, it is not for shutting the anus, as some have supposed, but is the direct antagonist of the sphincter ani muscle. By enclosing the bladder, the levator ani acts upon it also ; for the neck of the bladder passing through a slit in its fibres, while the levator ani is acting, this slit is drawn, as it were, round the neck of the bladder, and so the urine is for the time prevented from flowing. It is as a sphincter to the bladder, which prevents our passing the

urine and fæces at the same moment. By surrounding the lower part of the bladder, and enclosing the prostrate gland, and the vesiculæ seminales, which lie upon the back of the bladder, this muscle affects these parts also, and is perhaps the only muscle which may be supposed to empty the vesiculæ, or to compress the gland, pulling upwards at the same time, so as to press the back of the penis against the pubes, to maintain the erection, and to assist the accelerator muscles. By enclosing the bladder, vesiculæ, prostrate and anus, this muscle produces that sympathy among the parts, which is often very distressing, as in gonorrhœa, the stone in the bladder, constipation, piles, and other diseases of these parts: for piles, constipation, or any cause which may excite the action of the levator muscles, will cause erections, a desire to pass the urine, and an obstruction in the discharge of it.*

CLV. The *MUSCULUS COCCYGEUS* is a thin, flat muscle, which arises by a narrow point from the inside of the pelvis, at the spine of the os ischium; is implanted, expanded and fleshy, into the whole length of the os coccygis; can be useful only by pulling up the point of the os coccygis; which is just equivalent to raising the circle of the anus; so that from every circumstance of its form and use, it might be fairly enough described as being merely the back part of the levator ani muscle.

The perinæum, where the bulb begins, is the point into which all the muscles are united; for the ejaculator muscle, and the sphincter ani muscle, touch at the beginning or point of the bulb; and a small pointed slip of the sphincter ani, going upon the bulb, connects them firmly together. The transversalis perinæi come across the perinæum from either side; and the levator ani muscle comes down to meet the sphincter, so that the sphincter ani, the levator ani, the transversalis perinæi, and the ejaculator muscles, all meet in one point, viz the back of the bulb. They secure the perinæum, and support the heavy viscera of the abdomen; if they be unskilfully cut in performing lithotomy, it will be difficult to extract the stone. In that operation, the incision passes by the side of the anus, and on the inside of the tuber ischii; and our knife accordingly cuts clean across the transverse muscles, which stand as a bar across the perinæum; it passes by the side of the erector muscle, need not touch it, or

* There is a muscle described by Mr. Wilson, as a levator, or compressor urethrae. The origin of this muscle is from the arch of the pubes, and its fibres run round the membranous part of the urethra, being inserted on the lower part into each other: it is situated between the Cowper's gland and the levator ani, being separated from the last muscle by a thin fascia, and some small veins. In order to make out this muscle distinctly, and with as large a tendon as Mr. Wilson describes it, it is necessary to sacrifice several of the fasciæ.

touches it slightly, and by a sort of chance : it must not touch the ejaculator muscle ; for whosoever says he cuts the ejaculator cuts too low, and performs his operation ill.* After the first incision we get deep into the pelvis, and cut the levator ani. The surgeon does not observe these muscles, on account of any danger which may attend wounds of them, but takes them as marks for the true place of his incision and a good operator will be careful to have them fairly cut that they may be no hindrance to the extraction of the stone.†

We find of course a difference in the muscles in the female perineum. There is an erector clitoridis, which has the same origin as in the male, and it is inserted into the crura clitoridis, in the same manner that the erector penis is inserted into the crura penis. The next muscle is the sphincter vaginæ, which is a large muscle taking an origin from the sphincter ani and posterior side of the perineum ; it is inserted into the union of the crura clitoridis. We find likewise a transversalis which, though taking the same origin as in the male, is a very small muscle ; its insertion is into the union between the sphincter vaginæ and sphincter ani : in the two next muscles, viz. sphincter ani and levator ani, there is no difference, except that they are attached to the vagina instead of the penis.

CHAP. VIII.

MUSCLES OF THE THIGH, LEG, AND FOOT.

MUSCLES MOVING THE THIGH-BONE.

THE muscles belonging to the thigh-bone arise all from the pelvis or trunk. The *PSOAS MAGNUS* and *ILIACUS INTERNUS*, come from within the pelvis, and its forepart, and passing under the femoral ligament, go down to be implanted into the trochanter minor ; and by this obliquity of their insertion, they turn the toes outwards, and bend the thigh. Other

* Those anatomists who describe the origin of the ejaculator to be from the ramus ischii object to this.

† The detractor urinæ is but the muscular coat of the bladder ; the sphincter vesicæ is but a denser fasciculus of this common coat of the bladder. I should no more think of describing them here than of describing the coats of the intestines or stomach. These muscles of internal parts, with the muscles of the internal ear, &c. I reserve for those books which describe the organs and viscera.

3. THE THIGH IS MOVED FORWARDS AND INWARDS,

By the psoas magnus, iliacus internus, pectinalis, triceps,	}	which are inserted into the	{	trochanter minor, <hr/> linea aspera.
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FASCIALIS. I begin with this muscle, as it is necessary in the dissection. The thigh is enclosed in a very strong sheath, which, like that of the arm, sends down among the muscles strong tendinous septa or partitions; and the muscles are enclosed in these septa, and the great muscles of the leg are supported by it, in their strong and continual actions. The tendinous fascia of the thigh arises chiefly from the spine of the ilium, partly (over the groin) from the external oblique muscle of the abdomen. Every fascia has something added by each muscle, and takes a new increase and adhesion at each bone which it passes. It is always strengthened by adhesions to joints, and comes down from them thicker upon the muscles below; and so this fascia of the thigh, which arises chiefly from the spine of the ilium, descends, covering all the muscles of the thigh: it sends partitions down to the linea aspera and trochanters; it has a new adhesion, and a new source of tendinous fibres at the knee; it adheres most remarkably at the inner side of the tibia, and then descends to the calf; it covers all the leg, and is again re-enforced at the ankle; and this I believe to be a juster history than the common idea of making it an expansion of the small tendon of the small muscle, which I am now to describe; for the fascia is too essential to the strength of the leg, and would be found there, though this muscle were away, as is the case with the palmar expansion.

This fascia rightly consists of two plates; one is that which comes down from the crest of the ilium, and from the muscles of the belly; the other, that which arises purely from the tendon of the musculus fascialis, and which is at the same time connected with the capsular ligament of the femur, and with the trochanter; and so the muscle lies betwixt the two plates of the fascia: and as the fascia, at this part, takes at least a re-enforcement from the capsular ligament and from about the trochanter major, the fascialis muscle may be said to be inserted into the trochanter.

So this great tendinous fascia has these connexions: the crest of the ilium; the ligament of Paupart, at the rim of the belly; the crest and arch of the os pubis; the tuber ischii, and so back along the coccyx, to the ridge and processes of the

sacrum ; the ligament of the joint, the great trochanter ; and the linea aspera, all the way down to the knee, where its last adhesion is very strong, and from whence it comes off again, much strengthened.

It is thicker on the outer side and back part, and very thin on the inner side of the thigh ; and it dives with perpendicular division among the muscles of the thigh.

CLVI. The FASCIALIS MUSCLE — The muscle is named tensor vaginæ femoris. It arises from the upper spinous process of the ilium, (*i. e.*) from the forepart, or very point of its spine, by a tendon of about an inch in length. It is very small at its origin, and at its termination. It is thick and fleshy in the middle, swelling out ; it extends downwards, and obliquely backwards, almost to the middle of the thigh, and there it terminates obliquely, betwixt the two lamellæ of the membrane to which it belongs.

Its use is chiefly as an abductor, and to make the fascia tense, to prepare the muscles for strong action ; and perhaps, by its adhesions about the trochanter, it may have some little effect in rolling the thigh, so as to turn the toes inwards, and oppose the Gemini.

CLVII. PSOAS MAGNUS.—This and the following muscle come from within the body to move the thigh forwards. This is a very long and fleshy muscle, of considerable strength, of constant use, perpetually employed in moving the thigh forward or in supporting the pelvis upon the thigh-bone, so as to preserve the equilibrium of the body.

It is named from the **PSOAS LUMBUS** ; is a large round muscle, very strong, of great length, filling up all the space upon either side of the spine, and bounding the pelvis at its side. It comes from under the ligament arcuatum of the diaphragm ; for it arises first by its uppermost head from the last vertebra of the back, then successively from each of the vertebræ of the loins. It sticks close to the lumbar vertebræ ; for it arises not only from the transverse processes but from the sides of the bodies. These heads do not appear, for they are covered by the body of the muscle, which goes down thick and round, till it reaches the sacro iliac symphysis, and then being united to the internal iliac muscle, they descend through Paupart's ligament.

CLVIII. The PSOAS PARVUS does not, like this, belong to the thigh, but is a muscle of the loins, which arises along with this one from the last vertebra of the back, and the first of loins.

It is a small and delicate muscle, ends in a slender tendon, which goes down by the inner side of the great psoas, but does not go out of the pelvis along with it : it stops short, and is im-

planted into the brim of the pelvis, into the os ilium near the place of the acetabulum : it bends the spine upon the pelvis. This muscle is more regular in the monkey ; in the dog it is seldom wanting. It is said to be more frequently found in women than in men ; in both, it often is not to be found : but sometimes, in strong and big men, three psoas muscles have been found.

CLIX. The *ILIACUS INTERNUS* is a thick, very fleshy, and fan-like muscle, which occupies the whole concavity of the os ilium.

Its origin is from the internal lip of the crista ilii and transverse process of the last lumbar vertebræ : it adheres to all the concave surface of that bone, down to the brim of the pelvis ; to the forepart of the bone under the spinous process ; and to a part also of the capsular ligament of the joint : all its radiated fibres are gathered together into a tendon at the ligament of Paupart. This tendon is longer on the lower than on the upper surface : for below, it slides on the pubis as upon a pulley, and continues tendinous that it may bear the friction ; but above it is unconnected, or it is connected only by loose cellular substance ; and there it is quite fleshy. Just under the ligament, the two tendons are joined, whence they bend obliquely round, to be implanted into the lesser trochanter.

The psoas magnus and iliacus internus are two very powerful muscles. Their chief use is to bend the thigh, and more peculiarly of the lumbar one to support the body. The great blood vessels come down along with these two muscles : the muscles and vessels are both surrounded with loose cellular substance ; matter often forming behind the abdomen, round the psoas muscle, is named the psoas abscess, and penetrating under Paupart's ligament, bursts in the thigh at last and is commonly fatal.

CLX. The *PECTINEUS* OR *PECTINALIS*, so named from its arising at the pecten or os pubes, is a broad flat square muscle : it lies along-side of the last described muscles, and is inserted with their common tendon. It arises flat and fleshy from that part of the os pubes which is bounded on the upper part by the linea ileo pectinea, and on the lower by a ridge running from the tuberos angle of the pubes to the upper part of the acetabulum, and is implanted into the linea aspera, immediately below the trochanter minor, by a tendon flat and long, pretty nearly of the same extent and shape with its origin.

This muscle lies immediately under the skin and fascia lata ; and by its bending round under the thigh-bone, it has three actions ; to close the knees together ; to pull the thigh forward ; to perform rotation, turning out the toe ; and, in certain posi-

tions of the limb, it will pull the thigh back, assisting the extensor muscles.

CLXI. The **TRICEPS FEMORIS** is a broad flat muscle, with three heads, arising from the os pubis, and inserted into the whole length of the *linea aspera* down to the condyle, and serving for pressing the knees together, or bringing the thigh forwards.

The triceps consists of three heads, which lie in different layers, one above the other; and have so little connexion among themselves, that they have been more commonly, and I think properly, described as three muscles. These three parts of the muscle are indeed for one common use: but they are of very different forms: for they do not even lie on the same plane: one is long, another shorter by one half, a third longer than both the other two; so that they have been commonly described under the names of **ADDUCTOR PRIMUS** or **LONGUS**; **ADDUCTOR SECUNDUS** or **BREVIS**; **ADDUCTOR TERTIUS** or **MAGNUS**.

1. The **ADDUCTOR LONGUS** is the uppermost layer; its border (for it, like the *pectinalis*, is a flat muscle,) ranges with the border of the *pectinalis*. It arises from the upper and forepart of the pubis and the ligament of the symphysis by a short roundish tendon, very strong: it swells into a thick fleshy belly, not round, but flattened; the belly grows flatter as it goes down towards the thigh-bone; it ends in a flat and short tendon, which is inserted into the *linea aspera* in all its middle part, viz. about four inches. Thus, the muscle is of a triangular form, with its base in the *linea aspera*, and its apex on the os pubis. Its head or origin lies betwixt the *pectinalis* and the *gracilis*; its upper edge ranges with the *pectinalis*; its lower edge lies upon the *triceps magnus*. It is called *longus*, because it is longer than the next muscle.

2. The **ADDUCTOR BREVIS** lies under the *adductor longus* and is of another layer of muscles; for as the first layer consists of the *pectinalis*, *triceps longus*, and *gracilis*, this layer consists of the *obturator externus*, *triceps brevis*, and *triceps magnus*. The *triceps brevis* is exceedingly like the former, in rising near the symphysis pubis, by a thick and flattened tendon, swelling like it into a strong fleshy belly; like it, it grows flat, and is inserted by a short flat tendon into the inner trochanter and *linea aspera*. But it differs in these points; that it is less oblique, for this muscle being shorter, goes more directly across betwixt the pelvis and the thigh: that it is placed higher than the last, so that whereas the layers are inserted into the middle of the thigh-bone, this one is inserted into the lesser trochanter, and only the upper part of the *linea aspera*; and the *triceps*

longus is a superficial muscle, while this is hidden under it, and behind it. The longus takes its rise from the very crest of the os pubis; this takes its origin from the forepart of the os pubis, from the limb just under the crest, so as to be immediately under the head of the longus.

3. The ADDUCTOR MAGNUS, the third head of the triceps, is a very long and flat muscle, lying behind the other heads. It arises by a short tendon, just under the tendon of the adductor brevis; it continues to have a fleshy origin all down to the ramus, and to the tuber ischii (*i. e.*) from the flat edge of the thyroid hole. From this broad origin, it goes to be implanted into the thigh-bone the whole length of the linea aspera, its fibres having various degrees of obliquity, according to their insertion, for the uppermost fasciculi go almost directly across, to be inserted flat into the upper part of the linea aspera; the succeeding fasciculi go more and more obliquely as they descend, the lower part of the muscle following that rough line which leads to the condyle, and the last fibres of all are implanted, by a tendon of considerable length, into the condyle itself. This adductor magnus makes as it were a flat partition betwixt the fore and the back parts of the thigh; and it is about three inches above the condyle that the great artery passes betwixt this tendon and the bone perforating the triceps, to get from the fore to the back part of the thigh, and down into the ham.

The use of all these muscles is entirely the same, making allowance for their various degrees of oblique insertion; and they must be very powerful, by the great distance of their origins from the centre of that bone which they move, so that while other muscles pull in a direction very oblique, these three heads of the triceps must pull more at right angles, and therefore at a more favourable direction.

CLXII. The OBTURATOR EXTERNUS is named after the obturator ligament, from which it arises. The ligament and the muscles shutting up the foramen thyroideum are named OBTURATORS, and it is sometimes named ROTATOR FEMORIS EXTORSUM, from its turning the thigh outwards. It arises from the ramus of the ischium and os pubis, where they form the margins of the thyroid hole; and from the outer surface of the ligament, which it occupies entirely, leaving only room for the obturator vessels and nerves. It is a short muscle; its origin is broad, and its insertion narrow, so that it is of a conical form; for the flesh of its muscles is gathered very soon into a round short tendon, which twists under the thigh bone betwixt it and the pelvis; so that it is in a manner rolled round the thigh-bone, being inserted into the root of the great trochanter. It

pulls the thigh forwards, but is more peculiarly a rotator of the thigh. This muscle is of the second layer, and the succession of all the muscles is this; the upper layer consists of the psoas and iliacus, where they come out from the abdomen, of the pectinalis, and of the long head of the triceps; the second layer consists of the short head of the triceps; and the third layer consists of the obturator externus at the upper part, and the triceps magnus, or third head of the triceps, all down to the condyle.

GLUTÆI.—There are three glutæi muscles, each under the other, and each smaller than the muscle which covers it. The **FIRST**, arising from the back part of the ilium, the back of the sacrum, and the sacro-sciatic ligament, forms the whole hip, and descends so low as to be inserted into one-third of the length of the linea aspera, and into the root of the great trochanter.

The **SECOND** arises from all that portion of the ilium which is before this one, and from the back of the bone, and goes down to be inserted into the very top of the great trochanter.

The **THIRD** arises from the back of the bone below the last; and it is inserted into the root betwixt the apex of the great trochanter and the neck of the bone.

CLXIII. The **GLUTÆUS MAXIMUS** arises from the back of the ilium nearly one half its length; from the joining of the ilium and sacrum; from all the spines and irregularities of the sacrum; and from the sacro-sciatic ligament. Its thick fleshy fasciculæ come in a winding and oblique direction down to the thigh-bone; and, being gathered into a flat and pretty broad tendon, it is inserted into the root of the trochanter major, and down three inches of the linea aspera. This is one of the largest and most fleshy muscles of the body; covers all the other muscles of the hip; forms the contour of the hip; pulls the thigh backwards, or the body forwards upon the thigh, when the thigh is fixed: and being a wide spreading muscle, which in a manner, surrounds its joint, its different portions act with different effects; not only according to their natural direction, but according to the accidental positions of the pelvis with regard to the thigh-bone.

CLXIV. The **GLUTÆUS MEDIUS** OR **MINOR** is smaller than the former but like it. It arises from all the outside of the ilium not occupied by the glutæus major. It, like the other, is a fan-formed muscle; for its fibres converge from its broad origin in all the back of the ilium, to form a short flat tendon which is inserted into the back, or into the very top of the great trochanter. It lies in part under the glutæus maximus; but its chief part lies before the glutæus maximus; and as certain portions of the muscle are before the thigh-bone, there

are positions of the pelvis and thigh-bone in which it will pull the thigh forwards, although its proper office is to assist the *glutæus magnus* in pulling the thigh backwards, and moving it outwards from the body.

CLXV. The *GLUTÆUS MINIMUS* is a small radiated muscle, which lies deep and quite under the former. It has, compared with the former, a very narrow origin; for it arises chiefly from the lowest part of the back of the ilium, viz. that part which forms the socket for the thigh-bone, and a little higher up, and from the border of the sciatic notch. Its origin from the *dorsum ilii* is bounded by a ridge, which extends from the upper part of the acetabulum to the notch. It forms a short, flat, and strong tendon, which is fixed under the root of the *trochanter major*, betwixt the *trochanter* and the neck of the bone; so that these muscles are inserted in this succession; first the great *glutæus*, below the root of the *trochanter*, and into the *linea aspera*; the middle *glutæus* into the back and top of the *trochanter*; and the smallest of the *glutæi* is implanted into the roughness under the root of the *trochanter*.

GEMINI.—The *gemi* are two muscles, or rather one *biceps* muscle; but the heads are so distinct, that they are reckoned two, and so much alike, that they are named *GEMINI*.

CLXVI. The uppermost the larger and stronger muscle, arises from the spinous process of the *os ischium*.

CLXVII. The second or smaller head arises in like manner from the *tuber ischii*, upon its ball or outer end. They are fleshy in their whole length. They meet, and unite their tendons at the great *trochanter*. They are inserted firmly along with the following tendon, at the root of that process.

CLXVIII. The *PYRIFORMIS*, or *pyramydalis*, comes from the hollow of the *sacrum*, runs in the same line with the lesser *glutæus*, and is inserted with the two last named muscles in the root of the great *trochanter*.

Its origin is from the hollow of the *sacrum*, rising from the *vertebræ* of that bone, by three or four small fleshy digits; and from the *sacro-sciatic* notch, it runs betwixt the *glutæus minor* and *gemi*, and its round tendon is inserted betwixt them, somewhat connected with each.*

The *pyriformis*, *gemi*, *obturator internus*, and *quadratus*, form what some anatomists have called *MUSCULI QUADRIGEMINI*; and they are so much alike in insertion and use, that it would be waste of time to repeat what has been said of the *gemi* and *obturator*.

This muscle, the *pyriformis*, like the others, rolls the thigh outwards. Its name is from its shape.

* This muscle is frequently divided by the great *sacro-sciatic* nerve.

CLXIX. The **OBTURATOR INTERNUS**, once named **MARSUPIALIS**, or **BURSALIS**, arises from all the internal surface of the obturator ligament, and from all the edges of the thyroid hole, from the ilium, ischium, and pubis. Its origin is therefore circular and fleshy. It runs along the inside of the os ischium, turns round that bone betwixt the spinous process and the tuber. The hollow there is guarded with cartilage, and this tendon runs in the hollow, like a rope round a pulley; passing this it runs betwixt the two legs of the gemini, and its tendon is united to theirs: and the three appearing almost like one tendon, are inserted together into the root of the trochanter major. These, then, might with some propriety be named one muscle; all the three, viz. the two gemini muscles, and the obturator muscle passing between them, were once accounted as one muscle, and then it seemed to be a muscle with two bellies, and an intermediate tendon; and this intermediate tendon, with two fleshy ends, give it the appearance of a purse, thence named **MARSUPIALIS**, or **BURSALIS**.

CLXX. The **QUADRATUS FEMORIS** is a thin flat muscle, passing in a transverse direction betwixt the tuber ischii and the thigh-bone.

It arises from the lower and flattened surface of the **TUBER ISCHII** by a strong tendinous beginning. It goes a little obliquely upwards and outwards, and is inserted into the back of the great trochanter, in that roughness which is found just where the trochanter is joined to the bone, and goes obliquely betwixt the trochanter major and the trochanter minor.

It rolls the thigh-bone, so as to turn the toe outwards, and pulls it almost directly backwards.

The **MOTIONS** of the **THIGH** must be performed by many very strong muscles, as it moves under the weight of the whole body: and it seems to be curiously contrived, that the muscles fit for moving the thigh forward, should in certain positions of the thigh, move it backwards; also giving an increase of strength to that motion of the thigh in which most strength is required.

There are but two or chiefly two points for insertion; the trochanter major and trochanter minor. These two points are so oblique, that no one muscle nor set of muscles, performs any direct motions; for they all twist round the bone's axis, to get at their insertion. The glutæi, the pyriformis the gemini, the quadratus, the obturator internus, and obturator externus, all bend round the axis of the thigh-bone to reach the **TROCHANTER MAJOR**. These now may be called the abductors of the thigh, to pull it outwards; but we should conclude from

this direction, that they could not pull the thigh backwards, for the thigh-bone would turn on its axis and elude their action.

The *psaos magnus*, the *iliacus internus*, the *pectinalis*, and the *triceps*, do in the same manner go round the inner side of the bone: the two first to be implanted into the *trochanter minor*, the two latter into the *linea aspera*, just below it. These are justly named adductors of the thigh: their chief use is to draw the thighs together, and this is their combined effect: when the adductors act by themselves, they pull the thigh forwards, moving the leg, rolling the thigh-bone, and turning the toe out in a graceful step; which is most peculiarly the effect of the *pectoralis* and *triceps*. But when we are to finish the motion, by pulling forward the body, which is the same with pulling back the thigh, it is not merely the antagonists of these muscles, as the *glutæi*, the *gemini*, &c. which must act. Were the *glutæi* to act alone, they would rather turn the thigh upon its axis outwards than pull it back; but the *triceps*, &c. act again in conjunction with the *glutæi*, &c. and by the action of the *triceps*, the inner *trochanter* is fixed: the further rolling of the thigh is prevented; the full effect is given to the *glutæi* muscles. When the *glutæi* act, they pull the thigh directly backwards, assisted by the *triceps*, *pectinalis*, and others: for now the thigh-bone is so far advanced before the body, that those muscles, as the *triceps* which were benders of the thigh in its first position, are extensors when it is advanced a step before the body; or, perhaps, it will be more explicit to say, that when the thigh is moved one step before the body, the *iliacus internus*, *psaos magnus*, and *triceps* muscles, agree with the *glutæi* muscles in bringing the trunk forwards to follow the limb, and then in fixing and stiffening the trunk upon that limb, till the other thigh is advanced again a step before the body.

The MUSCLES of the LEG are the most simple of all; for the knee is a mere hinge, at least, it is so in all our ordinary motions, so that there is no action to be performed, but those of mere flexion and extension, and there are only two classes of muscles to be described, the extensors and the flexors of the leg.

1. The EXTENSORS of the LEG. The only muscles which extend the leg are those four which may be very fairly reckoned a *quadriceps extensor cruris*. Indeed the French anatomists arrange them so. *Sabbitier* call them the *triceps femoris*. These muscles, which all converge to the *patella*, and are in-

serted in it, are, *RECTUS FEMORIS*,—*CRURÆUS*, or *FEMORÆUS*,—*VASTUS EXTERNUS*,—*VASTUS INTERNUS*.

And these are all implanted by one tendon ; and because the joint being a hinge, bending only in one direction, its muscles could have given but one motion however oblique their origin and course had been.

2. The *FLEXORS* of the *LEG* are one on the outside, and four on the inside of the leg ; the tendons of the outside being implanted into the upper knob of the fibula, and those in the inside into the rough head of the tibia, forming the ham-strings and extending their tendons or aponeurotic expansions downwards upon the leg.

INSIDE FLEXORS.

<i>Sartorius,</i>	<i>Gracilis,</i>
<i>Semitendinosus,</i>	<i>Semimembranosus.</i>

OUTSIDE FLEXOR.

Biceps.

EXTENSORS OF THE LEG.

CLXXI. The *RECTUS FEMORIS*, sometimes *RECTUS CRURIS*, is so named from its direction ; it arises by two heads. The first or greater head arises from the lower spinous process of the ilium by a short round tendon ; its second head is in a different, and somewhat of a curved direction ; for it comes from the edge of the acetabulum, and from the capsular ligament. These join together, and form a flat tendon of four inches in length, which becomes gradually fleshy and larger down to its middle, and then again contracts towards the patella. There is a middle tendinous line, running the whole length of the muscle, especially conspicuous on its back part and towards that central line all the muscular fibres converge.

The rectus is united at the sides to the vasti, at the back part of the cruræus ; and its tendon, along with that of the cruræus, goes to be directly implanted into the rotula or patella.

The rectus cruris is the first of those muscles which Sabatier calls the *TRICEPS FEMORIS* ; they may be more properly named the *QUADRICEPS CRURIS*.

This large mass of muscle or flesh enwraps the whole of the thigh-bone behind as well as before ; for, first, the *CRURÆUS*

arises fleshy from all the forepart of the bone. The *VASTUS EXTERNUS* from the great trochanter, and all the back part and outer side of the bone; and the *VASTUS INTERNUS* arises, in like manner, from the lesser trochanter, and all the inner side of the bone, from the trochanter major all round to the origin of the *cruræus*.

CLXXII. The *CRURÆUS* arises from the forepart of the femur, between the two trochanters, and it continues its origin from the forepart of the femur, the whole way down to within two inches, or little more of the patella. About three inches from its origin it is joined by the *VASTUS EXTERNUS*, which unites with it at the outer edge and forepart; and the *VASTUS INTERNUS* comes into it about five inches below its origin, and it joins it at the inner edge and forepart. At its lower part it is joined to the tendon of the rectus, to form but one large tendon, which is inserted into the rotula. By Albinus, the plate of this muscle is given in union with the two vasti, which is the best method of describing the muscle, as it is very seldom to be made out distinct from the two muscles.

Under the *cruræus* are sometimes found two little muscles, or rather two little slips of this muscle, which are quite distinct. They arise on the forepart of the thigh-bone, two or three inches above the capsule of the joint; and they are inserted into the capsule on each side of the patella, evidently for the purpose of pulling it up, to prevent its being caught; and when these two (*SUBCRURÆI*) are not found as distinct muscles, some fibres of the *cruræus* supply their place.

CLXXIII. The *VASTUS EXTERNUS* is the largest of these three muscles.

Its origin is, by a pretty thick and strong tendon, from the lower and forepart of the trochanter major; and it continues its origin from the root of the trochanter all down the *linea aspera*, to that rough line which goes to the outer tuberosity of the thigh-bone.

It touches the end of the *cruræus* about four inches below its origin, and continues attached to it the whole way down; and then it forms a flat tendon which connects itself with the tendon of the *RECTUS FEMORIS*, and then embraces, in a semi-circular manner, the outside of the patella. And several of the fibres of this aponeurosis not only cross over the rotula, but go down over its opposite side to glide along the head of the tibia, and to be inserted into the inner side of the knee.

CLXXIV. The *VASTUS INTERNUS* is neither so large nor so fleshy as the *VASTUS EXTERNUS*; but it is exceedingly like it in all other respects.

It arises from the forepart of the trochanter minor, just un-

der the insertion of the *psoas magnus*; and it continues its origin from the *linea aspera* the whole way down to the inner condyle, exactly opposite to the origin of the *vastus externus*; they leave just a channel betwixt them. The *vastus internus*, very soon after its origin, joins itself to the *cruræus*, or middle portion, and accompanies it in all its length; and, at the distance of two inches from the *rotula*, it unites itself with the tendon of the *cruræus* at its internal edge; and this tendon completes that junction which unites the four muscles into a *quadriceps cruris*. This *vastus internus* descends much lower, in a fleshy form, than the external *vastus* does, and forms that fleshy cushion which covers the inner side of the knee-joint. Its tendon embraces the *rotula*, somewhat in the same circular form with the *vastus externus*; and, like the *externus*, it sends some fibres across the knee-pan, to be inserted in the outer part of the head of the *tibia*.

The *RECTUS*, and the *VASTUS EXTERNUS*, *INTERNUS* and *CRURÆUS*, form one large mass of flesh, which embraces and encloses all the thigh-bone; and they are so connected, that the *cruræus* cannot be separated, and cannot be neatly distinguished.

The use of these four muscles is evident: to extend the leg, and to bend the thigh on the trunk, or reciprocally to bend the trunk on the thigh. This, or these two motions alternately, is the common use of these muscles, as in walking; and they are most peculiarly useful in running and leaping.

After describing a large mass, conjoined in one tendon, and concurring in one simple action, it is superfluous to say that its power must be great. This power must be still farther increased by the *rotula*, which removes the force from the centre, and gives the advantage of a pulley, which it really and truly is; without this pulley, these muscles could be of no use in certain situations; for instance, in the recumbent posture: for then the extending muscles, being in the same line with their bones, could have no further power; but the *rectus*, by the pulley of the *rotula*, and by its attachment to the basin, raises the trunk, or at least helps the *psoas*, the *iliacus*, and the muscles of the belly.

The *rotula* is again attached to the *tibia* by a strong ligament to sustain the pulling of these great muscles.*

* These muscles are in continual action; for their office is to resist the bending of the knee, which would happen by this encumbent weight of the body; so that the continual support of the body depends wholly on these muscles; and they are the great agents in running, leaping, walking, &c. Since by extending the knee they raise the weight of the pelvis and trunk, and of all the body, they must be very powerful; and accordingly, when they are weighed against their antagonist muscles, we find them greatly to exceed, for the *QUADRICEPS*, (*i. e.*) the *rectus*,

FLEXORS OF THE LEG.

CLXXV. The **SARTORIUS** or **TAYLOR'S MUSCLE**, is so named from its bending the knees, and drawing the legs across. It is the longest muscle, and a very beautiful one extends obliquely across the whole length of the thigh, crossing it like a fillet or garter, about two inches in breadth.

It arises from the upper spinous process of the os ilium, by a tendon about half an inch in length; its thin flat belly extends obliquely across the thigh, like a strap, and is inserted into the same oblique form into the inner tubercle of the head of the tibia; its aponeurosis spreads widely, going over the whole joint of the knee, a thin sheet of tendon.

From the oblique position of the muscle, it might in action change its place; but it is so far embraced by the *facia lata*, and is tied by such adhesions, as to form something like a peculiar sheath of itself.

It turns the thigh like the *quadratus gemini*, and *obturator* muscles. It also bends the leg upon the knee; and when the leg does not yield, it bends the thigh upon the pubes; or where the thigh is also fixed, it bends the body forwards; but in performing that action, whence it has its name, it does all these; for first the leg and thigh are rolled, then the thigh is raised, then the leg is bent to draw it across. Though a small muscle, yet it is of great power from its origin, and in some degree, its insertion also, being much removed from the centre of motion.

CLXXVI. The **GRACILIS**, sometimes called **RECTUS INTERNUS FEMORIS**,* is a small, flat, thin muscle, in its general shape somewhat like the *sartorius*.

It arises by a flat tendon of two inches in length from the *ramus* of the os pubis, and near the symphysis, and it passes immediately under the integuments down to the knee; it passes by the inner condyle of the knee, in the form of a short round tendon, and, as it bends behind the head of the tibia, it is bound down by a bundle of tendinous fibres, which, crossing it go to the back part of the leg. After passing the head of the tibia, it turns obliquely forwards and downwards; it here runs behind the tendon of the *sartorius*, and before that of the *semitendinosus*. It is inserted with the *sartorius* into the side of the tuberosity, at the top of the tibia.

crurus, and *vasti*, will weigh four pounds, while the *BICEPS*, &c. their antagonists, weigh but two pounds. This experiment was often repeated by the great Cowper, for Mr. Brown, who was delivering lectures on muscular motion.

* **GRACILIS**, is from its smallness; **RECTUS INTERNUS**, is from its straight direction.

This muscle runs also in a line so wide from the centre of motion, that its power is very great. It serves chiefly as a flexor of the leg; when the leg is fixed, it must by its origin from the pubes be a flexor of the thigh, and an adductor in nearly the same direction with the pectineus and triceps; and it is worth observing, that while the knee is straight, the sartorius and the gracilis cannot bend the knee; they, on the contrary, keep it steady and firm; but when the knee is bent, they come into action; for in proportion as the muscles which have made the flexion are contracted, they are less able to contract farther, and therefore it is desirable, that more muscles should come into play.

CLXXVII. The SEMITENDINOSUS is so named from its lower half being composed of a small round tendon; and as tendon was once misnamed nerve, this is the SEMINERVOSUS of Winslow, Douglas, and others.

Its origin is from the tuberosity of the ischium (along with the semimembranosus and touching the biceps,) by a short thick tendon. It also arises by many oblique fasciculi of fibres, from the posterior portion of its opposite muscle the biceps cruris. This cross connexion betwixt the two muscles continues for three inches down from the tuber ischii; it then departs from the biceps, goes obliquely inwards, and is flattened and contracted into a tendon, six inches from the knee and getting round the head of the tibia, it comes forward to be inserted into the tuber, at the head of that bone. At this place, the tendon grows broad and flat; it is expanded and as it were grasps the inner side of the knee; its upper edge is joined to the lower edge of the tendon of the gracilis, so that the sartorius, gracilis, and semitendinosus are implanted like one muscle; and this tendinous expansion seems like a capsule, for enclosing the heads of the tibia and femur, and for strengthening the knee-joint. The semitendinosus bends the leg.

CLXXVIII. The SEMIMEMBRANOSUS has its name from the muscle, which is flat, thick, and fleshy, beginning and ending with a flattened tendon, somewhat like a membrane, but infinitely thicker and massier than such name should imply.

It arises from the tuber ischii, before the semitendinosus and biceps. It arises a broad, thin, and flat tendon of about three inches in length. It becomes fleshy and thick in its middle, but it soon becomes thinner again, and terminates in a short tendon, which gliding behind the head of the tibia, is inserted there.*

* The two tendons of this muscle, the membranous tendon at the head, and this smaller one by which it is inserted, stand so obliquely, that the muscular fibres be-

This muscle has little connexion with any other. It lies under, or more particularly speaking, on the inside of the semitendinosus, and the two together form the inner ham-strings. The ham-string muscles contribute also to another motion. Though when extended the tibia cannot roll, yet when we sit with our knees bent, it can roll slightly; and such rolling is accomplished by these muscles. All these muscles which bend the leg, and which consequently extend the thigh at the same time, are muscles of great power, because they arise in one common point, the tuber ischii, and that point is very far distant from the centre of motion.

There is still one small muscle, a flexor of the leg, which performs this rotation during the bent state of the knee, with most particular power.

CLXXIX. The *MUSCULUS POPLITÆUS*, which is so named from its lying in the ham, is a small triangular muscle, lying across the back part of the knee-joint, very deep under the ham-strings, and under the muscles of the leg.

Its origin is from the outer condyle of the thigh-bone, and from the back part of the capsule of the joint. Its tendon is short and thick, but of no great extent. It passes fleshy behind the knee-joint; and it is inserted broad into a ridge on the back part of the tibia; so that by small origin and broad insertion, it is a fan-like muscle, its upper fibres being almost transverse, and its lower fibres nearly perpendicular. Besides bending the leg, it is useful by pulling aside the capsule to prevent its being caught.

CLXXX. The *BICEPS CRURIS*, so named from having two heads, a long and short one, lies immediately under the skin, in the back part of the leg, running down from the pelvis to the knee, to form the outer ham-string.

It is the single flexor on the outside of the thigh. Its origin is from the outer part of the tuber ischii, by a tendon of an inch and a half in length. And this tendon is, in its origin, closely united with that of the semitendinosus for two inches, or at least the whole length of the tendon. After a short, but very thick fleshy belly, it degenerates into a tendon, especially on its back part; and this tendon, which begins above the middle of the thigh, is continued the whole way down.

About one-third down the bone is the beginning of the second, or short head, which has its origin all the way down the linea aspera, to the line above the outer condyle of the thigh-bone; and here it is somewhat connected with the origin of the vastus externus muscle, and the insertion of the glutæus

twixt them must be very oblique; for the membranous tendon descends low upon the back part or edge, and the tendon of insertion begins high upon the fore edge of the muscle.

magnus. The tendon of the two heads are joined a little above the inner condyle, and go outwards to be inserted into the outer part of the head of the fibula, forming the outer hamstring.

Its insertion surrounds the head of the fibula, and a small portion also sinks betwixt the bump of the fibula and the inner head of the tibia, to be implanted into it also.

This muscle, like the opposite ones, serves for bending the leg. The short head simply bends the leg. The long head assists the short one in bending the leg, and is also a muscle of the thigh.

The muscles of the foot are six EXTENSORS and two FLEXOR MUSCLES.

EXTENSORS.

GASTROCNEMIUS vel GEMELLUS,	}	lying on the back part of the leg.
PLANTARIS,		
GASTROCNEMIUS INTERNUS vel SOLEUS,	}	on the outside of the leg.
TIBIALIS POSTICUS,		
PERONEUS LONGUS,		
----- BREVIS,		

THE FLEXORS are,

The TIBIALIS ANTICUS,	}	lying on the forepart of the leg.
The PERONEUS TERTIUS,		

CLXXXI. The GASTROCNEMIUS is often divided into three muscles, named GASTROCNEMII or GEMELLI. But, far from counting thus, we should rather favour the arrangement of Douglas, who couples this with the next muscle, as forming a quadriceps, or two muscles joined with two heads each, and he calls it the EXTENSOR SURALIS.

The GASTROCNEMIUS is the great muscle of the calf of the leg, its two heads are two very large and fleshy bellies, which arise from the tubercles of the thigh-bone. The inner head is the larger, and arises by a strong tendon from the back of the inner condyle, and a little way up the rough line; and it has also a strong adhesion to the capsular ligament of the knee.

The outer head is shorter than this: it arises in the same way, from the outer tubercle of the thigh-bone; and the two muscles meet and run down together, forming the appearance of a rapha, by the direction of their fibres; but the two bellies continue distinct till they meet in the middle of the leg. They are distinct at their back part; but, at their forepart, they

are connected by a tendinous aponeurosis, or strong but flat tendon ; and the two bellies being about the middle of the leg, united firmly, they form a large flat tendon, very broad at its beginning, which unites with that of the soleus a little above the ankle.

CLXXXII. SOLEUS.—This name is from its resemblance to the soal fish ; and it is often named **GASTROCNEMIUS INTERNUS.** This, like the last muscle, has two **HEADS** which arise from either bone.

One head arises from the head of the fibula, and continues to adhere to one-third of the upper part of the bone ; another head arises from about three inches of the part of the tibia, immediately below the insertion of the popliteus. The first of these heads is large and round ; the second is smaller and round ; they unite immediately ; and a large fleshy belly is formed, with still a conspicuous division betwixt the flesh of the two heads. The great tendon begins about half-way down the leg, but still is intermixed with fleshy fibres till it approach the heel. A little below the middle of the leg, this tendon is united with the tendon of the gastrocnemius, to form the great back tendon, named tendo Achillis ; and sometimes, though very rarely, chorda magna.

The tendon is large ; it grows smaller as it approaches the heel ; when it touches the extremity of the heel-bone, it expands to take a firmer hold.

In running, walking, leaping, &c. this muscle, with the extensors of the leg, are the principal agents. The external gastrocnemius has double power ; for, arising from the tubercles of the thigh-bone, it, is both an extensor of the foot and a flexor of the leg ; but the gastrocnemius internus is a mere extensor of the foot, and both together have such strength as often to break the tendo Achillis.

CLXXXIII. PLANTARIS.—This muscle is named from a mistaken notion of its going to the planta pedis, or sole of the foot, to form the planter aponeurosis, like the palmaris of the hand : but, in fact, it does not go to the sole, but is a mere extensor of the foot, inserted along with the tendo Achillis.

This long and slender muscle is situated under the gastrocnemius externus. It arises from the external condyle of the femur, wholly fleshy ; it also has an attachment to the capsular ligament of the joint ; after an oblique fleshy belly, of about three inches, it forms its small flat tendon. The tendon runs betwixt the inner head of the gastrocnemius and the solæus ; and when the tendo Achillis begins, the tendon of the plantaris attaches itself to the inner edge, and forepart of the Achillis tendon ; it accompanies it down to the heel, running in a

groove which seems made to receive it; and it is implanted with the tendo Achillis, into the inner side of the heel-bone. It is often wanting.

The use of this muscle is to tuck up the capsule, in the great bendings of the knee joint, and to assist the gastrocnemii muscles.

The PERONÆI muscles are those which arise from the fibula. They are named from their length being different; the PERONÆUS longus being as long again as the BREVIS, for it is one-half longer in its origin, the one rising at the head, the other at the middle of the bone; and again, it is one-half longer at its insertion, going fully round under the foot to the opposite side, while the shorter peronæus stops at the side of the foot to be inserted.

CLXXXIV. The PERONÆUS LONGUS is so named from its lying along the fibula. It arises partly tendinous, chiefly fleshy, from the upper knob of the fibula, and from the ridge of the bone down to within three inches of the ankle. It has another small slip of a head from the upper part of the tibia, above where the fibula joins; it has also adhesions to the tendinous partition, which separates this from the EXTENSOR DIGITORUM COMMUNIS and the SOLEUS.

Its tendon begins very high, above the middle of the leg, and it continues to receive the fleshy fibres, almost at right angles in the penniform manner. The tendon is concealed down to about or below the middle of the leg. Then it is seen immediately under the integuments, and we can easily distinguish it through the skin, being that acute line or string, which runs down behind the outer ankle, and which gives shape to that part.

In passing the outer ankle it runs down through a cartilaginous pulley, or annular ligament, which also transmits the peronæus brevis: it leaves the peronæus brevis on the side of the foot; and passing by itself in a groove of the heel-bone it bends obliquely across the arch of the foot, goes quite down to the opposite side, and is inserted into the metatarsal bone of the great toe, and the great cuneiforme bone on which it is founded. Under the eminence of the os CUBOIDES, it suffers great friction, so as to be thickened to a degree of ossification, and to resemble a sesamoid bone. It is also thickened in a lesser degree, as it passes the outer ankle; and in all this length, it is tied down by a strong ligamentous expansion.

It is a powerful extensor of the leg; it also gives that obliquity to the foot, which is so handsome and natural, and useful in walking. This muscle particularly turns down to the ground, the inner edge of the foot; so it presses to the ground

the ball of the great toe, and that is the part which touches the ground, and which feels sore after long walking, or violent leaping or running; It is by that part we push, in making a step; so that this muscle is perceived to be continually active in all motions of walking, leaping, running, and more particularly in dancing.

CLXXXV. The *PERONÆUS BREVIS* is like its fellow except in length and insertion. Its origin is from the ridge of the fibula, beginning about one-third down the bone, and continuing its adhesion the whole way to the ankle. It also has adhesions to the tendinous partition which is betwixt it, and the common extensor; so that these two muscles are, by such adhesions, very difficult to dissect. It is smaller at its origin, but increases in its fleshy belly as it descends; and it is fleshy lower down than the *peronæus longus*. It is, like it, a penniform muscle. The tendons of the two *peronæi* pass together, by the outer ankle, in the same ring; but the tendons cross each other; for the *peronæus longus* is in its belly more forward. The *brevis* lies under and behind it, quite covered by it, and yet the tendon of the *brevis*, by creeping under the *longus*, gets before it, just under the outer ankle: and from that it runs in a separate groove, superficially upon the outer edge of the foot, to be inserted into the metatarsal bone of the little toe. In both muscles the tendon is upon the outer edge, and begins almost as high as the upper head of each muscle. This tendon of the *peronæus brevis*, the shorter one, is small where it passes through the pulley, and expands when it reaches its insertion, that it may grasp the metatarsal bone firmly. The tendon of the longer muscle also expands a little, and somewhat in the form of a hand and fingers, taking hold of two bones by three little heads.

This muscle assists the former in extending the foot, and coincides well in its oblique action with the last; for, as the last turned down the inner edge of the foot, this turns the outer edge upwards, which is exactly the same motion.

CLXXXVI. The *PERONÆUS TERTIUS* is a third muscle, having its origin from the fibula; but as its tendon passes before the maleolus externus, and as it is inserted into the outside of the foot, it has a contrary action to the *peronæus longus* and *peronæus brevis*. The *peronæus tertius* lies on the forepart of the fibula, and rises from the middle of that bone, and down to near its lower head. Its tendon does not pass into the same sheath with the *peronæus longus* and *brevis*, but goes under the annular ligament on the forepart of the ankle-joint to be inserted into the root of the metatarsal bone, which sustains the little toe. It is much connected with the extensor commu-

nis digitorum, that there is often great difficulty in dividing the two. The action of this muscle balances the connexion of the tibialis anticus, and the two together bend the foot, that is, bring it to an angle with the leg.

CLXXXVII. The TIBIALIS POSTICUS is a penniform muscle; its tendon goes round the cartilaginous pulley of the inner ankle.

It is named TIBIALIS from its origin, and POSTICUS from its place.

It arises from the back part and ridge of the tibia, from the opposite part of the fibula, and from the interosseous membrane below these. Some fibres pass between the bones at the upper part, and take an origin from the forepart of the tibia; and it continues its attachment to the interosseous ligament, quite down to the ankle. It has also strong attachments to the surrounding tendinous partitions. Its fibres are all oblique and go to the middle tendon, which is in the heart of the muscle. About the middle of the tibia, this tendon begins to emerge from the fleshy belly; it grows gradually smaller, but still continues to receive flesh quite down to the ankle. It passes in the groove of the inner ankle, and is retained there by such a ligament as holds the peronæi. After passing the ligament, it expands in the hand-like form, to grasp the bones of the tarsus; and it is expanded much more than the peronæus, for it sends roots down among the bones both of the tarsus and metatarsus, so as to take hold first on the lower rough part of the naviculare in passing over it. Then it is implanted into the two first metatarsal bones, then into the calcaneum, and lastly into the os cuboides; and where it passes over the os naviculare, it is hardened into a sort of sesamoid bone. In short, it is implanted in the sole of the foot by a tendon like a hand, which sends down its fingers among the tarsal and metatarsal bones, to take the surest hold. This muscle pulls the foot in, so as to put the toes together, and when balanced by the peronæi, it directly extends the foot.

CLXXXVIII. The TIBIALIS ANTICUS crosses obliquely the forepart of the leg. It arises from the forepart and outside of the tibia, part of the fibula, and interosseous ligament. It begins just under the outer tuber, and continues its adhesion down two-thirds of the bone; then the tendon begins to be formed: and this muscle, like almost all the smaller ones of the leg, adheres to the tendinous partitions, and to the fascia, with which they are covered. The tendon begins almost with the origin of the muscle, but continues covered by the flesh, and not appearing till within four inches or so of the ankle, when it begins to pass obliquely over the leg, and having completed the cross-

ing above the ankle, it goes under the annula ligament in a peculiar ring, it runs along the side of the foot, and is implanted into the os cuneiforme internum, and a small production of the tendon goes forward to be inserted into the metatarsal bone of the great toe.

This muscle turns the great toe towards the leg, and when assisted by the peronæus tertius directly bends the foot.

MUSCLES OF THE TOES.

The long muscles of the toes are just four, two FLEXORS, and two EXTENSOR MUSCLES. The flexor muscles lie upon and tibialis posticus, or behind, betwixt it and the solæus. The extensor muscles again lie under the tibialis anticus, or at least their heads are under it, and their bellies only appear from under it, about the middle of the leg.

The flexor tendons follow the tendon of the tibialis posticus, over the pulley of the inner ankle into the hollow of the foot. The tendons of the extensor muscles keep with that of the tibialis anticus, and cross over the forepart, or raising of the ankle, where the tibia is united with the astragalus. And in dissection, we must follow these in an opposite order to that in which they are described, for next to the forepart of the solæus is, 1st, the FLEXOR POLLICIS; 2dly, the FLEXOR DIGITORUM; and 3dly, the TIBIALIS POSTICUS.

CLXXXIX. The FLEXOR LONGUS POLLICIS is small and pointed at its origin, and arises fleshy from three-fourths of the fibula, to within an inch of the outer ankle, and interosseous ligament. It grows thicker and larger as it descends, and adheres to the tendinous partitions of the tibialis posticus, and of the peronæi. Its tendon can be seen only about an inch above the joint of the ankle. It passes down behind the inner ankle, where it is bound in a sort of annular ligament. It there passes under the heel-bone, in the arch of the foot, betwixt the bones and the abductor pollicis; it then glides into the channel made by the two heads of the flexor pollicis brevis; it then passes betwixt the two sesamoid bones at the root of the great toe; it then goes forward in a sheath, to be inserted into the last bone of the great toe, at which implantation it is enlarged.

Its office is to bend the great toe; but it is also continually useful at every step in extending the foot, or in keeping the toe firm to the ground, while the gastrocnemii raise the heel:

and therefore we should not be rash in cutting away the great toe, for in its consists not the strength of the foot only, but of the leg.

CXC. The FLEXOR LONGUS DIGITORUM PEDIS is named in addition the PERFORANS, because, like the perforans of the hand, it runs its tendons through the split tendon of a smaller muscle, which is lodged in the sole of the foot. It is named also FLEXOR COMMUNIS, although there be less reason here, where there are no flexors for the individual toes, than in the hand, where there are separate flexors for the individual fingers.

It arises from the back and inner part of the tibia, its whole length, that is, from the end of the poplitæal muscle, and from the septum tendinosum, by which it is divided from the tibialis anticus, which lies immediately before it; and it continues this origin from the tibia down to within three inches or so of the ankle. About the middle of the muscle we find fibres coming across to join it from the outer edge of the tibia, and between these two sets of fibres the tibialis posticus passes. Its origin is not easily separated before from the tibialis posticus, nor behind from the flexor pollicis.

The tendon is not formed till near the ankle, (within two inches of it,) and the flesh still accompanies it quite down to the joint. It crosses the tendon of the tibialis posticus behind the ankle-joint, and goes forward in the groove of the os calcis, tied down by a sort of capsule, or annular ligament. In the arch of the foot, it crosses the tendon of the flexor pollicis, from which it receives a slip of tendon; and thus the office of either is assisted by the other, and could be wholly supplied by it; it then passes over to the middle of the sole, and growing flatter and thicker, divides into four flat tendons. These go forward, diverging till they arrive at the ends of their metatarsal bones; then they emerge from the aponeurosis plantaris, along with the common short flexor. Now both these tendons run under a ligamentous sheath, and are included in it under the first and second bones of the toes; and having perforated the short flexor opposite to the second joint, they are finally inserted into the root of the third or last bone of each toe. These tendons, like the corresponding ones of the hand, seem to be split with a sort of longitudinal fissure.

The proper use of this muscle is to bend the four lesser toes, to bend all their joints, but more peculiarly the last bone; and also to extend the foot keeping the point of the toes to the ground, consequently assisting the gastrocnemii, and all the muscles used in walking, &c.

CXCI. The *MASSA CARNEA JACOBI SYLVII*, or *PLANTÆ PEDIS*, flexor accessorius, lies in the sole of the foot; it is a small body of flesh, naturally connected with the flexor longus. The massa carnea arises from the lower part of the heel-bone, in two divisions, one (the external one) tendinous the other fleshy. It is upon the whole, pretty nearly of a square form; it joins the tendon of the flexor longus, before its division into tendons for each toe, and by the advantage with which it acts in consequence of its origin from the heel-bone, it must be of great assistance to the flexor. It is more generally considered in the light of a supplementary muscle; by some it is considered as a distinct muscle, and by others, as the origin and first beginning of the *lumbricales pedis*.

Thus Cowper considered the massa carnea, and the *lumbricales*, as one and the same; that the massa carnea joins the tendon, covers it with its flesh, continues fleshy along the common tendon, till at the bifurcation it also parts along with the four tendons, into four small fleshy muscles, which are called *lumbricales*.

Albinus, again, paints the massa carnea distinctly, terminating at the common tendon, and the *lumbricales* as arising distinct from each of the divided tendons.

CXCII. The *FLEXOR BREVIS DIGITORUM* is also named the flexor sublimis or perforatus. It arises from the lower part of the heel-bone, or the bump upon which we stand. It arises by very short tendinous fibres, and being placed immediately under the plantar aponeurosis, it takes hold of it, and also of the tendinous partitions betwixt it and the two abductors of the small and of the great toe, which are on either side of it. Under the metatarsal bones, it divides itself into four heads; their tendons begin earlier upon the side next the foot; they grow round, emerge from betwixt the dentations of the plantar aponeurosis; they then pass into the vagina, or sheath of each toe; and on this, the first phalanx, they lie over the tendons of the long extensors. About the root of the first bone, they divide into two little bands, which form a split (like the perforatus of the fingers) for the passage of the long tendon.

The long tendon passes through it upon the second joint of the toe; and immediately after the perforated tendon fixes itself by the two forks to each side of the second bone or phalanx of the toe.

Its use is to bend the first and second joints of the toes, but most peculiarly the second. The obliquity of the long flexor is exactly balanced by a corresponding obliquity of the short flexor; for the tendon of the long flexor coming round the

inner circle, runs obliquely outwards to reach the toes, while the short flexor coming from the heel, which is towards the outer edge of the foot, runs in a like degree obliquely inwards and meets the other at an acute angle near the toes.

CXCIII. The LUMBRICALES must be dissected after the short flexor. They need no description, since they exactly correspond with those of the hand. They rise, like them, in the forks of the flexor tendons. They, like them pass through the digitations of the aponeurosis. They pass on to the first bone of the toes, and like the lumbricales of the hand, creep over the convexity of the bone, to be united along with the tendons of the extensors. Their insertion is always at the side of the toe next the great toe, and their use is to bend the first-joint of the toes, and to draw them towards the great one, making an arch in the foot, and assisting the transversalis pedis. The FLEXOR BREVIS lies most superficially upon the sole of the foot, having its origin from the inner surface of the aponeurosis. The MASSA CARNEA lies deeper, having no origin but from the tip of the heel-bone, and being soon implanted into the tendon of the long flexor. The LUMBRICALES again arise from the tendons of the long flexor, beginning just where the massa carnea ends in it: and the LUMBRICALES are the flexores primi internodii; the SHORT FLEXOR MUSCLE, the flexor secundi internodii; the LONG FLEXOR, the flexor tertii internodii digitorum.

EXTENSORS OF THE TOES.

CXCIV. The EXTENSOR LONGUS DIGITORUM PEDIS is very difficult to dissect, from its numerous adhesions.

It arises properly from the head of the tibia, at its outer and forepart, just under the knee; but it also has strong adhesions to the inner surface of the fascia, to the tendinous partitions betwixt it and the tibialis anticus before and betwixt it, and the peronæi behind, and also to the interosseous ligament, and to the edge of the fibula. Its small origin soon becomes thick, and is divided even from the beginning very perceptibly into three distinct portions. These soon form three round tendons, which go obliquely inwards, pass under the annular ligament of the ankle, and run in a ring of it, peculiar to them and the peronæus tertius. They then traverse the two bands of the annular ligament upon the forepart of the foot, and now they change their direction a little, and go from within outwards, and diverge towards their proper toes. There are three portions of muscle, and four toes to be

moved ; the first portion divides its tendon into two, at the joint, so that the first portion serves both the first and second toe, the second the third toe, and the third serves the fourth toe. Here the tendon of the long extensor receives four other tendons ; first, of the *interossei externi* ; secondly, of the *interossei interni* ; thirdly, of the long flexor ; fourthly, of the *lumbricales* ; and these form a very large sheath, quite surrounding the toe.

These do not only, like other extensors, extend the toes, but also, by the divergence of the tendon, expand them, or separate them one from another.

CXCV. The *EXTENSOR DIGITORUM BREVIS* is so connected with the extensor longus, that it is natural to describe them together. It is placed just where the buckle lies, upon the rising of the foot, having its origin from the heel-bone, and running obliquely inwards.

Its origin is from the outer side, and forepart of the heel-bone, and also from part of the annular ligament. It is smaller where it arises by a short tendon from the heel-bone, but it gradually increases in size ; it divides early into four heads, which are muscular, and very distinct ; the two inner of which are larger, the two outer more slender : each head has already formed an oblique tendon under its flesh, which begins to appear naked about half way down the metatarsal bones. These tendons cross those of the long extensor, and pass under them nearly about the end of the metatarsal bones. Then one is implanted into the first bone of the great toe, and on the inside of the long tendon under which it had turned. The second, third, and fourth tendons are inserted into their respective next toes, and the little toe is left without one. The three last of these tendons form a sort of slit, the two sides of which pass along the sides of the toes, surrounding the long tendon, something like a perforatus ; so that the three last tendons are inserted along with the long tendons into the last bone of the toes.

The obliquity of this short muscle counteracts the obliquity of the long ; and it serves to extend and to spread the toes, and to pull them away from the great toe.

CXCVI. The *EXTENSOR POLLICIS PROPRIUS* is a very slender muscle running from the top of the leg to the second joint of the great toe. It arises from the fibula, a little below its head, takes fibres from the interosseous ligament, grows tendinous as it approaches the foot, then passing under the annular ligament, and the cross ligament of the foot, it goes onwards to the second joint of the toe over the first.

The succession in which these muscles lie, under and be-

hind each other, is this ; first the *tibialis anticus*, the outermost muscle, arises from the forepart of the tibia, nearest the forepart of the leg, at the ridge of the tibia : secondly, the *extensor pollicis* lies immediately behind, and under the *tibialis anticus* ; thirdly, the *extensor digitorum communis* lies behind that : and fourthly, the *peroneus tertius* lies behind the common extensor, like a part of that muscle.

These extensor tendons are bound down by cross bands, resembling the annular ligaments of the wrists. The general fascia of the thigh is continued over the knee, and down the leg : it is much strengthened at the knee, where it adheres to each point of bone ; it descends very thick and strong over the leg, binding down and strengthening the *tibialis anticus* and *extensor* muscles. The sheath grows thinner towards the ankle, but where it passes over the joint it is so remarkably strengthened by its adhesions to the outer and inner ankles, that it seems to form two distinct cross bands, which, going from the point of the outer ankle, across the extensor tendons, to the point of the inner ankle, forms a strong crucial ligament, resembling the annular ligament of the wrist ; so that this, which is called the **CRUCIAL LIGAMENT** of the ankle or foot, is plainly but a strengthening of the common sheath.

The remaining muscles in the foot are the **INTERROSEI**, which in the foot, are found single on the lower surface or sole, but double, and two-headed upon the upper part of the foot. The **ABDUCTOR FLEXOR**, and **ADDUCTOR POLLICIS**, which surround the great toe, something like those of the thumb ; and the **ABDUCTOR** and **FLEXOR MINIMI DIGITI**, surrounding the little toe ; and there is a small slip of muscle, the **TRANSVERSALIS PEDIS**, which goes across the sole of the foot.

CXCVII. The **ABDUCTOR POLLICIS** arises by very short tendinous fibres, from the knob of the *os calcis*, and also from a ligament which stretches from this knob to the sheath which belongs to the *tibialis posticus* ; and it arises also from the tendinous partition betwixt it and the short flexor of the toes ; and although it forms a tendon beginning opposite to the cuneiform bone, the tendon is not naked, till it has reached the middle of the long metatarsal bone. It unites with the short flexor of the same toe, and is inserted into the first bone or phalanx of the toe at its root, and *os sesamoideum*. Its use is to pull aside the toe, and at the same time to bend it a little ; it also curves the foot itself, for a joint, or any loaded part, is much better supported by muscles than by ligaments ; and this arch requires support more than almost any other part.

CXCVIII. FLEXOR BREVIS POLLICIS. This muscle is much shorter than the last, and lies betwixt the ABDUCTOR and the ADDUCTOR ; it lies immediately upon the metatarsal bone.

Its origin is by a pretty long tendon from the heel-bone, and from the OS CUNEIFORME EXTERNUM, by two separate slips, from the heel-bone, being a full inch in length ; it also adheres to the membranous partitions on either side of it. It is soon divided into two heads ; one goes to the abductor, and the other goes to the adductor to have the tendons inserted with theirs, into the root of the first bone or phalanx. These tendons contain the sesamoid bones ; and the parting of the two heads makes a channel for the tendon of the long flexor to run in.

Its use is to bend the first joint of the great toe.

CXCIX. The ADDUCTOR POLLICIS is the third and last portion of the muscle which encircles the great toe.

It arises from the heel-bone, by a tendon as long almost as that which it gives the abductor ; it does not immediately arise from the heel-bone ; but there is a ligament extended from the heel-bone to the os cuboides, and it arises from that ligament : this is the ligament, under which the tendon of the peroneus longus glides. It takes likewise an origin from the cuneiforme externum. The adductor is divided into two fleshy fasciculi or heads ; these unite, and going obliquely inwards, are inserted either into the sesamoid bone, or directly into the first bone of the great toe.

CC. The TRANSVERSALIS PEDIS extends transversely across the sole of the foot at the head of the metatarsal bones ; it is a very small muscle, and resembles a good deal the palmaris brevis.

It arises from the forepart of the metatarsal bone of the great toe, and the sesamoideum internum and is inserted into the under and outer part of the anterior extremity of the metatarsal bone of the little toe and ligament of the next toe.

Its use is said to be, to make a sort of gutter in the foot, by drawing the heads of the metatarsal bones together ; but is it not evident, that this is one of many instances of muscles being a more perfect support than ligaments ?—It is a support, having a sort of intelligence, contracting or relaxing, according to the necessity or degree of force ; indeed, except this use, it is not easy to assign any, for there is very little occasion for hollowing the foot in this direction.

CCI. The ABDUCTOR MINIMI DIGITI, like the abductor pollicis, is a pretty long muscle, but very slender, lying on the outer side of the foot.

Its origin is from the knob of the heel bone, and from the tendinous septum, which covers the flexor brevis ; it forms two small tendons in the same direction : one small and shorter tendon is fixed into the metatarsal bone, at its root ; the other goes forward, to be inserted into the root of the first bone of the toe, so that this muscle clearly performs both the offices ascribed to the other flexors. It bends the toe to which it belongs, and it extends and supports the tarsus in walking ; and it carries the toe a little outwards, from which it has its name.

CCII. The **FLEXOR BREVIS MINIMI DIGITI** is next, and is almost the same muscle in place and office : it is an exceedingly small muscle ; it just measures the length of the metatarsal bone, and arises from it. Its origin is from the root of the metatarsal bone of the little toe, and from the ligament by which that bone is connected with the os cuboides ; its small belly runs the length of that bone, and it is implanted by a short tendon, into the root of the first bone of the little toe.

Its use is to bend the toe.

CCIII. The **INTEROSSEI INTERNI** are three small muscles, seated in the planta pedis, as the interossei manus are in the palm of the hand. Their slender tendons pass through the openings of the aponeurosis plantaris, and, going on the inside of the toes, are, like the lumbricales, inserted along with the extensor tendons.

These pull the toes towards the great toe, bend the first joint, and extend the second and third.

CCIV. The **INTEROSSEI EXTERNI** are, like the corresponding muscles of the hand, four in number, and double headed, and have been named bicipites. They rise from the metatarsal bones, on each side of them : each has some little variety in its origin or course ; but it is far from being worth our while to describe each individually as many do : it is sufficient to observe their origin, and that their tendons all meet the tendons of the long and short extensors of the **LUMBRICALES**, and of the **INTEROSSEI INTERNI**, upon the backs of the toes ; so that the whole forms a web, aponeurosis, or sheath, which covers the upper part of the toe, and adheres to its point.

The office of these muscles is to extend the toes.

PLANTAR APONEUROSIS.—The palm and the sole are much exposed, and are especially defended by a thick tendinous aponeurosis. In the palm, there is the more reason to suspect expansion to proceed from the tendon of one muscle, because the tendon of the palmaris is inserted into it ; yet that is not probable ; for the tendon is very slender, and quite unfit for the generation of so broad a sheet of aponeurosis. In the foot, such an origin is still less probable ; for the plantaris tendon

does not terminate in the plantar aponeurosis, but is inserted into the heel-bone.

The plantar aponeurosis arises most distinctly from that part of the tuber of the heel-bone upon which we stand : it is divided into three sheaths. Sabbatier makes a middle, external, and internal portion of the same aponeurosis. Albinus also describes it as three distinct aponeurosis ; one for the middle of the foot ; one for the abductor of the great toe ; and one the aponeurosis of the abductor of the little toe ; all connected together only by their edges. Cowper considers it as a general expansion from the plantaris ; and it is from this prejudice that the muscle has its name.

But its true origin is from that part of the knob of the heel-bone on which we stand. The middle and more pointed tendon arises from the very point of the knob. The inner fascia arises from the inside of this ; and the outer one from the outside. And though thus divided into three heads, yet the whole origin is from the heel-bone. From this point the aponeurosis goes forward, expanding till it is as broad as the roots of the toes ; so that the whole has the shape of a sandal ; and as it expands, its fibres are scattered, so as to have a radiated appearance. Accordingly the part nearest the heel is thicker, while the broader part is thinner.

It goes forward like the sole of a shoe, till having approached the heads of the metatarsal bones, it is divided into five heads, corresponding with the five knobs ; and each of these heads again subdivides itself in two bands, which passing on each side of the heads of the metatarsal bones, is fixed into the sides, so as to leave room for the passing of the tendons, and nerves, and arteries.

Now this middle aponeurosis sends down a deep strong partition on each side of it ; which is the best reason that I know for making these three distinct aponeurosis ; for by these perpendicular partitions, the hollow of the foot is separated into three distinct chambers : under the middle one are concealed the tendons of the long flexors, with the lumbricales and short flexor muscles : under the outer one the flexors and abductor of the little toe ; and under the inner one the adductor, flexor, and the abductors of the great toe.

The uses of this great and very strong aponeurosis are ; that it protects all the parts, the blood vessels, muscles, and nerves that lie under it ; that it supports the arch of the foot, both in standing and in motion, passing from heel to toe like a bow-string across its arch : that it binds down the muscles, and consequently supports and assists them, in their strong actions : that it gives origin or part of their origin, to many of the mus-

cles ; which by their frequent and irregular adhesion to it, are very difficult to dissect : that it forms openings or rings, in which the tendons of the other muscles pass.

CHAP. IX.

OF THE MUSCULAR POWER.

THAT contractile power which resides in the muscular or living fibre, is a phenomenon the most wonderful and perplexing of all. When we cannot reach the true point, the mind too often condescends to the most trifling pursuits ; and so, when the older physiologists could not understand the intrinsic nature of this muscular power, they endeavoured to discover the size, the colour, and other external properties of the fibre ; foolishly desiring to know, what if known, could be of no avail. Colour was believed to be essential to the constitution of a muscle : but in fowls, in amphibious animals, in fishes, in worms, and insects, through all the gradations of animals of different species or different sizes, the colour of the muscular fibre change. In fishes and in insects, it is entirely white ; even in the human body, it is not essentially red : the blood which makes the fibre red may be washed away. Then why should we define a muscle by that accidental property which it so often wants, and of which it may be so easily deprived, while we may define it more truly by its contractile power, the only evidence of its nature, and its chief distinction in the system ; for the contraction of the iris constitutes its nature ; it is a muscle by truer marks than by its colour : and by the same rule, the muscles of the least insect are as perfect as the muscles of a man.

Philosophers of the last age had been at infinite pains to find the ultimate fibre of muscles, thinking to discover its properties in its form ; but they saw just in proportion to the glasses which they used, or to their practice and skill in that art, which is now almost forsaken. Some found the fibres to be of one equal size in all creatures, however various : others found them proportioned to the size, or age, or strength, of their subject ; but even such discrepancies are trivial to those which, in one of the greatest of these minute philosophers, are found almost in the same page ; sometimes affirming the ultimate fibre to be greater or smaller, according to the strength of the sub-

ject and again making them of equal size, in the whale and in the insect.

Others, less troubled about the ultimate size of these fibres, had conceived notions of their form, which in the credulity of the times, rose into the importance of doctrines, and from the first raw conceptions of their authors, were finally proved by the microscope, forsooth; and while one author was drawing his rhomboidal fibres, all conjoined in regular succession and another describing them also from the microscope, as consisting of six cylindrical fibres, involved in a spiral one, a third reckoned the fibres a succession of spherical bodies; and Cowper thought that he was injecting with quicksilver, chains of bells jointed with each other. For the honour of the age, these vanities are forgotten now. And why, indeed, should we seek the ultimate fibres of the muscle, or study their forms, when the discovery could not advance us one single step in the knowledge of its nature or essence? What avails it that we have discovered (if we have really discovered) the shape of the particles of the blood; the wave-like fibres within the substance of the nerves: or the jointed appearance in the smaller fibres of muscles? We do not understand the nature of the blood, the properties of the nerves, nor the contractile power of the muscles at all better by this peculiar form of the internal structure, than we do by the grosser marks of their external form.

Physiologists have, by a late sense of their own weakness been at last humbled to this becoming, but unwilling acknowledgement, that this contractility of the muscles is an original endowment of this living matter derived from the Creator, imparted in a way which we cannot know, and so attached to the organization of the muscular fibre, that where its organization is destroyed, this power is lost. We have resigned the search after a mechanical or physical cause, and seek only to learn the properties of this living power, and the excitements by which it is moved. To this end it is necessary to define this power distinguishing it from those feelings or motions which result from the nerves. The *vis insita*, being that power which belongs to muscles, is the source of motion and animal life. The *vis nervea*, being that property which is peculiar to nerves, is the seat of feeling, and the cause of voluntary motion relating chiefly to the enjoyments and consciousness of life; for life and motion exist even in plants, and in many creatures, which, not having nerves, have neither consciousness nor enjoyment, and in which the place of feeling is supplied by a less perfect instinct, by this *vis insita*, or some analogous inherent power.

This irritable power residing in muscles, may be defined the property by which muscles feel and re-act, upon certain stimuli being applied, without that feeling being conveyed to the sensorium, without a consciousness of action, without any other natural dependence on the system than that, while certain orders of muscles are obedient to their own stimuli only, as the heart to the blood, other orders of the muscles are ready to receive the commands of the will. And above all, so little dependent is this action upon the nerves, that it is as perfect in animals which have no nerves, and is for a time very perfect in the parts which have been severed from the systems to which they belonged. This power, inherent in the muscular fibre, belonging to its constitution, and not derived from without, is the *vis insita*, or irritability of Haller,* the *vis vitalis* of Goetter, the oscillation of Boerhaave, and the tonic power of Stahl. It is seen in the spontaneous and tremulous contractions of muscles when lacerated; as in wounds when cut in operations, when entirely separated from the body; as in experiments upon animals, like that tremulous motion which we often feel in various parts of the body, without any evident cause, and independent of the will. Even when the body is dead to all appearance, and the nervous power gone, this contractile power remains; so that if a body be placed in certain attitudes, before it be cold, its muscles will contract, and it will be fixed in that posture till the organization yields and begins to be dissolved; it is the same inherent power by which a cut muscle contracts and leaves a gap. This is but a feint indication of that latent power, which can be easily excited to the most violent motions, and on which all the strength of the muscles depends: for the ligaments, tendons, bursæ of joints, and all those parts which have no living power, are capable of bearing the same weight when dead as when alive. But such is the connexion betwixt the organization of a muscle and its contractile power, that the moment it dies its power is gone; and the muscle which could lift a hundred pounds while alive, cannot bear the weight of a few pounds when dead. This latent power may be brought into full action by various stimuli. The latent power itself is called *vis insita*, the acting power put into action, or the proof of the *vis insita*, upon applying stimuli, is called the irritability of muscles. This irritability is so far in-

* The irritability of a muscle is, perhaps, more properly the *vis insita*, or inherent power called into immediate action, by the presence of stimuli; and as for the names of Tonic Power, Vital Power, and the rest, the terms are quite undefined. and may, perhaps, have referred rather to the combined effect of all the powers of life, and of all the properties of inanimate matter, of nervous sympathy, elasticity, and of muscular power combined

dependent of nerves, and so little connected with feeling, which is the province of the nerves, that upon stimulating any muscle by touching it with a caustic, or irritating with a sharp point, or driving the electric spark through it, or exciting with the metallic conductors, as of silver and zinc,* the muscle instantly contracts; although the nerve of that muscle be tied, although the nerve be cut so as to separate the muscle entirely from all connexion with the system, although the muscle itself be separated from the body, although the creature upon which the experiment is performed may have lost all sense of feeling, and have been long apparently dead. Thus a muscle cut from the limb, trembles and palpitates for long after; the heart separated from the body contracts when irritated; the bowels when torn from the body continue their peristaltic motion, so as to roll upon the table, ceasing to answer to stimuli only when they become stiff and cold; and two often in the human body the *vis insita* loses the exciting power of the nerves, and then palsy ensues; or losing all the governance of the nerves, the *vis insita*, acting without this regulating power, falls into partial and general convulsions. Even in vegetables, as in the sensitive plant, this contractile power lives. Thence comes the distinction betwixt the irritability of muscles and the sensibility of nerves; for the irritability of muscles survives the animal, as when it is active after death; survives the life of the part, or the feelings of the whole system, as in universal palsy, where the vital motions continue entire and perfect, and where the muscles, though not obedient to the will, are subject to irregular and violent actions; and it survives the connexion with the rest of the system, as where animals very tenacious of life are cut into parts: but sensibility, the property of the nerves, gives the various modifications of sense, as vision, hearing, and the rest; gives also the general sense of pleasure or pain, and makes the system, according to its various conditions, feel vigorous and healthy, or weary and low. And thus the eye is sensible, and the skin is sensible; but their appointed stimuli produce no motions in these parts; they are sensible, but not irritable. The heart, the intestines, the urinary bladder, and all the muscles of voluntary motion, answer to stimuli with a quick and forcible contraction; and yet they hardly feel the stimuli by which these contractions are produced, or at least they do not convey that feeling to the brain. There is no consciousness of present stimulus in

* See a most ingenious dissertation by my pupil Mr. Fowler, the First writer in this country, on this very interesting novelty, where the operations of this new excitement are explained.

those parts which are called into action by the impulse of the nerves, and at the command of the will : so that muscular parts have all the irritability of the system, with but little feeling, and that little owing to the nerves which enter into their substance ; while nerves have all the sensibility of the system, but no motion.

The *VIS INSITA* is a power that is in continual force, preserving the parts ready for their proper stimuli, whatever these may be : one set obeying their own peculiar stimuli chiefly, while others are obedient to the nervous power, and the influence of the will. The heart is stimulated by the quantity or quality of its blood ; the stomach by the presence of food ; the intestines by their contents : the urine stimulates the bladder ; the venereal appetite stimulates the genital system ; the fœtus stimulates the womb ; and the voluntary muscles (if we may be allowed to guess at a thing so little known,) are excited by the nerves, and so are obedient to the will ; for, to our limited view, the nerves seem to be the sole messengers of these commands, and any stimulus to the nerves moves the muscles like the commands of the will. The absence of the due stimulus to each, or the presence of the ordinary stimuli in too great power, will excite enormous and irregular motions, as fulness of blood in the heart, poisons in the stomach, acrimonies in the intestinal canal, or the passions of anger or fear in the system of the voluntary muscles. The due stimuli preserve their right tone and action ; but these violent stimuli hurt their irritability, or moving power ; the heart acts weakly after fevers ; the appetite is languid after debauch ; the limbs are weakened by labour ; and the whole system is ruined by excess. Thus, the functions by which the system lives, the heart, the stomach, the bowels, and the womb, the various sorts of vessels by which the fluids are conveyed, are providently removed from the influence of the will ; for these are the machines of the system, whose motions could not stop, must not be interrupted, nor lowered, nor raised, but must move and act according to the needs of the system. Not left to the irregularities or carelessness of voluntary motions, they are governed each by its own peculiar stimulus, and act in a continued and equal course.

Thus, there are in the body two living powers, which are as cause and effect in all the motions of our system. The *NERVES* stand as an intermedium betwixt all external objects and our general sense ; by the impressions through these come pleasure and pain, and all the motives to action ; by the will, returned through the nerves, all voluntary motions ensue. Thus are the nerves, as internuncii, betwixt, the external im-

pression and the moving power. But nerves were never known to move under the influence of stimuli; the moving power is another property of a distinct part of our body, having its own arrangement of particles, and its own peculiar form. All motion then proceeds from the joint operation of either power; the nerves convey the impressions, while the muscles contain the power; and it is here, as in other natural effects, the external cause changes, while the inherent property, the subject of its operation, remains the same. The nervous power is the regulator of the system; it is the property suited to all the supports of life, upon which they act, and by which they maintain their power over our body; but is subject to continual changing; it rises and it falls, is perfect or low; but the energy of the muscle, which is to answer to this power, remains ever the same, while its organization remains: the nervous power is exhausted and languid; but the muscular power is always perfect, always ready for the excitement of stimuli, or for the commands of the will.

There is (if we may be allowed any expression so loose and indefinite) the will of the system, and the will of the mind; it is the will of the system, that, through the medium of nerves of wide sympathy and consent, governs and leads in harmony all the consenting functions of the body, and lowers and raises their powers, according to the weakness or strength, or fulness or wants of the body; while the will of the mind commands those voluntary motions, which it is its choice to perform. So natural seems that notion which has long prevailed, of an archæus, or presiding spirit, which, like a latent instinct regulates and preserves the system, prompts to what is right, and creates an aversion to what is wrong, and raises or allays the actions of the vital organs, preserving the system in health, and striving against disease. The voluntary muscles are put under the command of the will, while the involuntary muscles, by which the vital organs move, are insulated and mechanical, and depend less on our spirital part: for life and existence depends less on feeling, or that which is allied to our spirital part, and more on the irritable and moving power; and it was fit that this irritable power should be divided from our feelings and our will, which are irregular and transitory, and apt rather to derange than to preserve the system.

How this division is accomplished, we do not know in any surer way; but we see that the heart, the lungs, the stomach, and the intestines, have a proportion of nerves, so much lower than the muscles of voluntary motion, that their very existence has been denied. Yet there are nerves proper to the vital

parts ; the phrenic nerve goes to the diaphragm ; the par vagum to the heart, lungs, and stomach ; the sympathetic nerve to the heart, to the intestines and other viscera of the abdomen : these nerves are appropriated and distinct. Now, this question occurs : if the irritable power be in these organs, if they be endowed with the quality of feeling their own peculiar stimuli, and answering to their impulses, what need is there for nerves ? but they also have their nerves, that they may not want some living connexion with that system to which they belong : that they may flourish in its health, and languish in its diseases ; that they may act according to the needs, and be subject to the will of the system ; that the grand movers of the mechanical system may be affected in their turns by the spiritual part, and thus the digestion, the circulation, the venereal appetite, and every vital power, are languid and depressed, or lively and perfect, according to the conditions of the whole : and how these functions are moved by anger, or joy, or fear, needs not be told. But the vital functions also lose their action : " The heart acts weakly after fevers ; the appetite is languid after a debauch ; the limbs are weakened by labour ; and the whole system is ruined by excess." These organs have less dependence on nerves, and so suspicions arise, that the irritable power, the very basis of life, may also fail ; but how should it fail ? If the motions of our system cease, it must be either from the incapacity of the muscles, or from the loss of exciting power in the nerves. The nerves are liable to change, but the muscle retains its power till its organization be destroyed. When the irritable power of a muscle ceases, when the heart, for instance, begins to fail, whence can that loss arise ? Its power is not mechanically exhausted, else from what source could it ever be renewed ? It is not from any injury to its nerves ; for the heart, when cut out from the body, may be wearied out with constant stimuli, till it cease to act ; and it will recover by rest, without communication with the nerves : but it is perhaps such a derangement as happens in a spring, which, being long bent, loses of its elastic power : the arrangement of its particles suffers by straining ; they are composed by rest : and if the elastic power be thus restored in an inanimate spring much more should the contractile power recover by rest in the muscular fibres of a living system.

The *VIS INSITA* cannot be wearied nor exhausted ; so the heart is unwearied in its function, or if languid or too violent in its actions, that must be from the power of stimulus being lowered or increased, not from any change on the inherent power. The voluntary muscles also are unwearied ; and so, after great fatigue, we are sensible of cramps and irregular con-

tractions, showing that they are still active, but more loosely governed by the nerves, and not so fully under the command of the will. But the NERVOUS SYSTEM is more subject to weariness and to decay; the senses become tired; the feelings of the system are exhausted. It is from this failing of the nervous power, that violent exertions bring fatigue and pain: from this also that we need the refreshment of sleep; but during sleep, the heart, and all the involuntary muscles, unwearied in their functions, proceed still in the same regular and orderly course.

This irritability, or inherent power, not only keeps the muscles ready, each for its peculiar stimulus, but preserves a balance over the whole system of the muscles. We know that muscles maintain a constant action, independent of the nerves. The muscles of one side balance the opposite muscles; and if the muscles of one side be relaxed by palsy, the action of the opposite muscles instantly appears: or if a limb be luxated, and its muscles displaced, they persevere in a violent and spasmodic action, till they be restored each to its place. Have we not reason to believe, that if muscles were absolutely and entirely quiescent, they could not be so instantaneously called into action; but that by this continual tension or tone, they more readily follow the commands of the will: that by this lesser tension, they are prepared for greater action, and inclined to harmonize? for if all the muscles were quiescent, and one suddenly moved by the will, its antagonist would rise into undue action, and the co-operating or assisting muscles would be unprepared. Whereas, by this continual tension of all the muscles, one set is opposed to another, is consenting with it, and is ready to co-operate with it, or to oppose it in the due degree: the mind has but to incline the power towards one set, and immediate and orderly motions ensue.

The NERVOUS INFLUENCE, again, is as a mere stimulus to the voluntary muscles, as blood is to the heart, or the fœtus, or any foreign body to the womb. It loses its influence over the system faster than the ordinary powers of life do; and the irritable state of the muscles continues long after the voluntary motion or the power of excitement from the nerves is gone: for when we die slowly, this inherent power is exhausted in the struggles for life. If, while in perfect health, we are killed by a sudden blow, the irritable power of the muscles survives the nervous system many hours or days, and the flesh trembles, and the absorbents continue to absorb; and often, as after suffocation, we can, by operating upon this poor remains of life, restore the circulation, re-animate the nervous system, and recover that life, which seemed to

have entirely left the body ; and thus, the nervous influence, which seemed to animate the system, and to be the prime mover and source of life, owes its restoration to that which was thought to be but a secondary power. It is this remains of contractile power which fixes the dead body in whatever posture it is placed : it is this remains of irritability, which preserves freshness in the animal which seemed dead, but which is really dying still : for the moment this lingering portion of life is gone, the body dissolves, and falls down ; and so we judge of freshness, by the rigidity of the flesh, and foresee approaching putrefaction, by its becoming soft. There is no putrefaction in creatures suddenly killed, as in the accidents which happen to man, or in killing animals by a sudden blow ; in these the body continues fresh and susceptible of stimuli long after death : but if this inherent power, this irritable nature of the fibre, be exhausted before death, or in the moment of death, then does the body fall quickly into the condition of dead matter, running through those changes which are the only true marks of death. The fish, which is allowed to struggle till it be dead ; the ox, over-driven before it be brought to the slaughter ; the animal killed by lightning, which suddenly explodes (if we may be allowed the expression) all the powers of life ; in these the contractile power is effectually exhausted ; no mark of irritability remains ; putrefaction comes quickly on : and so in those who die of the plague, of poison, of fevers, or of any sudden and violent disease, which at once extinguishes life in the vulgar sense, and robs the system of that remnant of life, which the physiologist could produce to view ; in all these cases, the body becomes putrid in a few hours. If a body becomes putrid so early in warm climates, it is not merely because putrefaction is favoured by heat ; but it is because heat exhaust the vital power, and often a part of the body has lost its organized power, and is almost putrid before the whole be dead. We find, that we are wrong in this, that when a body has lost all feeling and motion, we pronounce it dead ; the nerves indeed have ceased to do their office ; all feeling and consciousness is gone ; but the mere animal power survives the nerves, and through it the whole system may be recalled into perfect life.

The powers and privileges of the nervous system must not be ranked too high, nor valued too low ; the perfect animal feels and moves by the nervous power ; but surely its muscles are actuated by a law of their own nature ; the heart of the chick begins to move, before we dare presume, that there is any organ for distributing this nervous power. The *punctum saliens*, is the heart of the chick ; it is seen beating while the

body of the chick is but a rude unformed, and gelatinous mass; daily this active centre encreases in strength and power; and it has a delicate feeling of stimuli, and it quickly re-acts, so as "to fly out into angry and perturbed motions," by the application of a stimulus. It is excited by increased heat and languishes when cold, till at last it dies; then it ceases to act, but still heat restores it to life; and is not the proof stronger in the grown animal, when we cut out the heart, which answers to stimuli for some time; at last, seems to have its power exhausted; it lies dead for some time, till it again recovers its power? If this power proceeded from the nerves, how could it be renewed? but if it reside in the muscle only, it may have been wearied, and may revive; its organization may have been deranged, and may be restored by rest from stimuli; and its parts may be composed again, resuming their relative situation, and their active arrangement and form; or though it may be insensible to a stimulus long applied, it may be still alive, even to a lower stimulus of another kind; or it may awake again to the feeling of that stimulus, which, by being too long applied, had lost its power.*

Sensibility depends upon the nerves; motion on the muscles: both are equally admirable and inscrutable; the one conducing to all the enjoyments and all the sufferings of life, and to the intellectual faculties of man; the other being the chief support of animal life, and the source of all the bodily powers.

As for the MECHANICAL POWERS, by which the contractions of the muscular fibre is forwarded or retarded, they are not what they have been believed; for we find few circumstances in the origin, insertion, or forms of muscles, to favour their power, but many by which their power is abridged. There are certain points, where the length of lever gives an increase of power. The mastoid process and the occiput are as levers for the head; the spines of the vertebræ for the back; the olecranon for the arm; and the pisiform bone for the hand. The pelvis, and the jutting trochanters are as the levers for the thigh; the patella is a lever for the leg; the heel-bone is a lever for the whole foot; and the arch of the foot is as a lever

* There is a consideration which is not attended to: sensibility and contractility are two distinct endowments of the living body, the one the property of the nervous matter, the other of the muscular fibre. When a sharp point is thrust into a muscle, it is not the muscular fibre which feels this injury, but the nervous matter in intimate distribution with the proper fibre: and we have here, no more than on other occasions, a proof of muscular contraction being the direct result of a stimulus to the muscular fibre. Sensibility must reside in a part, before that part be capable of receiving excitement, the contraction of the muscle is therefore the conjoint operation of the nerves and muscular fibres. C. B.

for the toes. These are not the whole, but they are, perhaps, the chief levers in the human body. In all the other implantations the muscle is fixed, not behind the joint, but betwixt the joint and the weight that is to be moved. There is a greater loss of power, when inserted near to the joint; there is less loss of power, when the tendon is inserted far from the joint, and though we call such insertion a longer or shorter lever, there is always some loss of power, and the true levers in the body are very few; far from providing mechanical forms to increase the power, nature has provided such a quantity of contractile power as to compensate for any loss of effect: so, in place of encreasing the effect of muscles by levers, pulleys and hinges, there is in almost every muscle a great abatement of its force, by the form of the bones which it is destined to move; for muscles lose of their effect, by their being implanted, not behind the joint, but betwixt the joint and the body to be moved; by the insertion of almost all muscles being very oblique, with respect to the motions which they are to perform, so that half their force is lost upon the immoveable end of the bone. Much force is lost by a muscle passing over many joints: one set of fibres in a muscle hinders the action of adjoining fibres, and every degree of contraction takes from that muscle an equal proportion of its power. Thus every where in the human body is power sacrificed to the form and fitness of the part; that the joints may be smaller than the limbs; that the limbs may be proportioned to the body: and beauty and convenience is gained by the sacrifice of that power, which is not needed in the system, since the wisdom and goodness of the Creator has appointed a degree of force in the muscles, more than proportioned to all this loss of the mechanical power. Those who will admire the ways of Providence, should know how to admire! Nature is not seeking to compensate for want of power, by the advantages of pulleys, and levers and mechanical helps; nor is it in the forms of the parts that the Infinite Wisdom is to be found: for among other gifts, such a portion of this spirit is given to man, that he has used the pulleys, and levers, accelerations of motion, and all the mechanical powers that result from it; he has invented valves of infinite variety, each perfect and true, to its particular office; he has anticipated all that he has found, in the mechanism of the human body; but the living power which compensates for the want of levers, which allows every where power to be sacrificed to the beauty, of form, which has strength in convulsive and violent actions, to break the very bones; this is the act of Infinite Wisdom, on which our admiration should chiefly dwell.

It is but the very elements of so deep a subject that can be delivered here. I must proceed to explain those provisions for easy motion, which may be considered as belonging to the muscles and bones, and as preparing us for a knowledge of the joints.

CHAP. X.

OF THE TENDONS, LIGAMENTS, BURSE, AND ALL THE PARTS WHICH BELONG TO THE BONES OR MUSCLES, OR WHICH ENTER INTO THE CONSTITUTION OF A JOINT.

THE bones and muscles themselves are but the smallest parts of that beautiful mechanism by which the motions of the human body are performed; for the parts by which the bones are joined to each other, or the muscles fixed into the bones, are so changed, and varied in their forms, according to the uses of each part, as to give a natural and easy shape to the limbs, security and firmness to their motions, and lubricity and smoothness to the joints by which these motions are performed; and this apparatus deserves our attention, not merely that we may know the forms of these joinings, but that we may learn something of the nature and uses of each part, and the various degrees of sensibility with which each is endowed; for, from this kind of study conclusions will arise, which may lead us to the knowledge of their diseases, suggesting the means of their prevention and cure.

There is a difference in the parts of the human body, according to the several uses for which they are designed; some are vascular and soft, others bony and hard; some sensible, and very prone to inflammation and disease, others callous and insensible, having little action in their natural state, and little proneness to disease.—The greater part of the human body is merely inanimate matter, united into a moving and perfect whole by the system of the nerves which abound in each creature, according to its wants, and are distributed in each system according to the uses and functions of every part. In some places there is such a conflux of nerves, as form the most delicate and perfect sense, endowing that part with the fullest life; while others are left without nerves, almost inani-

mate and dead, lest feeling, where it ought not to be, should derange the whole system.

The living parts of the system are the muscles and nerves; the muscles to move the body, and perform its offices, each muscle answering to its particular stimuli, and most of them obeying the commands of the will; the nerves to feel, to suffer, and to enjoy, to issue the commands of the will, and to move the muscles to action: but still the muscles have their own peculiar kind of life, superior to the nerves, and independent of them, always acting, always capable of greater action, always ready to receive the impulse of the nerves. It is a power which survives that of the nerves, acting even when severed from the general system; and acting often on the living body, without the impulse of the nerves, and sometimes in opposition to the will. The dead matter of the system* joins these living parts, and performs for them every subservient office, forms coverings for the brain, coats for the nerves, sheaths for the muscles and tendons, ligaments and bursæ, and all the apparatus for the joints; unites them into one whole by a continued tissue of cellular substance, which, from part to part through all its various forms, has no interruption, and suffers no change, but still preserves its own inanimate nature, while it joins the living parts to each other. The tendons, ligaments, periosteum, and bursæ, are all composed of this cellular substance, which, by its elasticity, binds and connects the parts, and, by its dead and insensible nature, is less exposed to disease, and is a fitter medium of connexion for the living system.

OF THE FORMS OF THE CELLULAR SUBSTANCE.

Under various modifications and shapes, the cellular substance performs most important offices among the living parts; 1. It forms CELLS over all the body, which allow the parts to glide and move easily, which contain the fluid that makes all the motion of parts more easy and free, which store up fat to fill the interstices, to support the parts in their action, to give a plumpness to all the body, and to be re-absorbed for the needs and uses of the system. This cellular substance is peculiarly useful to the muscles, dives in among them, keeps their fibres at such due distance, that each may have its action, supports and lubricates them; so that perhaps the difference

* This expression of the dead matter of the system must only be considered as a relative term, for these parts are not dead nor insensible, although their sensibility be ordered with such a relation to their office, as not to obstruct the play and motion of the limbs. C. B.

of strength, in health and disease, depends, at least, in some degree, upon the support. The thinner halitus makes the play of the fibres easy and free; and the fat not only supports the fibres in their action, but lubricates them so, that a want of it is painful, while a superabundance of it encumbers the body. And Haller seems to have believed, that a diseased increase of it might not only oppress, but almost annihilate the muscular fibre.

2. But it is still further essential to a muscle, that while it moves, it should neither be hurt itself, nor harm the surrounding parts. Therefore, where one muscle moves over another muscle, soft flesh upon soft flesh like itself, there can be no hurtful friction, and the cellular substance is loose and natural, preserving its common form. But where tendons rub upon tendons, or bones upon bones, or where tendons rub upon muscles, or upon each other, some defence is needed, and the cellular substance assumes a new form. The cells are run together into one large cell, with thicker coats, and a more copious exudation, so that, being more liberally bedewed with a gelatinous mucus, it prevents the bad effects of friction, and is called a *BURSA MUCOSA*, or *MUCOUS bag*. These mucous bags are placed under rubbing tendons, and chiefly about the greater joints; some are large, and others small; their glairy liquor is the same with that which bedews the cellular substance, or the cavities of the joints; and the provision of nature is so perfect, that the occasions which require bursæ seem to form them by friction, out of the common cellular substance.

3. It is often useful that an individual muscle should be enclosed in a tendinous sheath, to give it strength and firmness, and to preserve it in its shape, or to direct its force. All muscles, or almost all muscles, form for themselves individual sheaths, such as are seen enclosing the supra-spinatus and infra-spinatus of the scapula, the biceps humeri, and most of the muscles of the leg and thigh; but it is especially necessary that the whole muscles of the limb should be enclosed in some stronger membrane than the common skin, both to give form to the limb, and strength to its muscles, and to keep the individual muscles in their proper places, which otherwise might be luxated and displaced. And so the trunk of the body, the arm, the thigh, the leg, are bound each with a strong, smooth, and glistening sheath, formed out of the cellular substance, condensed and thickened by continual pressure. And this also is thicker and stronger, according to the need that there may be for such a help; for it is weaker over the flat muscles of the back, or of the abdomen, stronger on the arm, stronger still over the strong muscles of the thigh. It is hardly to be

distinguished in the child ; grows thicker and stronger as we advance in years and in strength, and in the arms of workmen it grows particularly thick and strong, encreasing in the back, shoulder or limbs, according to the particular kind of labour. These are the membranes, which, by enclosing the muscles like sheaths, are called the *VAGINA*, or *FASCIA* of the arm, the leg, the thigh, &c.

4. *TENDONS* or ropes were needed, for the muscles could not be implanted thick and fleshy into each bone, without a deformity of the limbs, and especially of the joints, which would have been not unshapely only, but which must have abridged them of their motions and uses. Where a muscle is not implanted directly into a bone, tendons are seldom required ; and so there are no tendons in the heart, the tongue, the œsophagus, the stomach, intestines, or bladder. But where tendons pass over bones, or traverse the joints, their force is concentrated into narrower bounds ; and long tendons are fixed to the ends of the muscles, to pull the bones. These tendons were once believed to be but the collected fibres of muscles, gathered into a more condensed form ; by which condensation, their properties of feeling and motion were lost, while they became hard, white, and glistening ; and it was believed that parts which were fleshy in the child, became tendinous in the adult. But we know by the microscope, that the tendon is not truly continued from the flesh ; that the fibres of the tendon, and of the flesh, are not in the same line, the fibres of all penniform muscles running into their tendon, in a direction more or less oblique ; and good anatomists have been able to separate the tendon from the flesh, without any violence, and with the bluntest knives,—Muscles are irritable, and have nerves ; tendons are quite dead, have no visible nerves, have neither feeling nor motion, nor any endowment by which we should believe them to be allied to the living parts of the system ; and many tendons, as the expansion of the palmaris, may be unravelled into mere cellular substance.*

5. The *PERIOSTEUM* is merely a condensation of the common cellular substance, formed in successive layers : and the tendons are of the substance of the periosteum ; they mix with the periosteum, and are implanted into it. In dissecting a child, we tear up the periosteum along with tendons and without hurting the bones ; but in process of time, the periosteum, and consequently the tendons, are inseparably fixed to the bones. The periosteum, tendons, fasciæ, and bursæ musosæ,

* The tendons are the continuation of the interstitial cellular membrane of the muscle ; and I have succeeded in unravelling them into a web. C. B.

are all of one substance, and of one common nature ; they are various modifications of that dead matter, which having but little vascularity, and no feeling, and hardly any disposition to disease, is the fittest for its office, and bears the roughest usage in our experiments, and the most violent shocks in the motions of the body, without any signs of feeling, and without falling into disease.

6. These tendons must be bound firmly down, for if they were to rise from the bones, during the actions of the muscles to which they belong, the effect of contraction would be lost, and they would disorder the joint, starting out in a straight line from bone to bone, like a bow-string over the arch of a bow. The same inanimate substance still performs this office also ; for the tendons of one muscle often split to form a sheath or ring for the next, or their tendons, after taking hold of the bone, spread their expansion out over all the bone, so as to form an entire sheath for the finger and toe ; or there is a wide groove in the bone which receives the tendons, and it is lined with a cartilage, and with a lubricated membrane ; the membrane comes off from the lips of the groove, or from corners or edges of the bone, passes over the tendons, so as to form a bridge, or often it forms a longer sheath, as in the fingers, or where the peronæi muscles pass behind the ankle, and thus the VAGINA OR SHEATHS of the TENDONS are connected with the tendons, periosteum, and other modifications of the common cellular membrane.

7. The periosteum which has run along one bone, leaves it at the head, and forming a bag for the joint, goes onwards to the next bone. Thus, the periosteum of all the bones is one continued membrane, passing from point to point : each bone is tied to the next by its own periosteum, and this membrane, betwixt the end of one bone and the beginning of the next, is so thickened into a strong and hard bag, as to form the capsule of the joint ; and the periosteum is assisted in performing this office, by the tendons, fasciæ, bursæ, and all that confusion of cellular substance which surrounds the joint. The CAPSULE of the JOINT is then a firm and thick bag, which, like a ligament, binds the bones together, keeps their heads and processes in their right places, contains that glairy liquor with which the heads of moving bones are bedewed, and prevents the adjacent parts falling inwards, or being caught betwixt the bones in the bendings of the joints. The capsule of every joint proceeds from the periosteum, and is strengthened by the tendons ; it is formed like these parts, out of the cellular membrane ; and when a bone is broken, or its periosteum destroyed by any accident or disease, when a tendon snaps

across, when a joint is luxated, and the capsule torn, the injury is soon repaired by a thickening of the cellular substance round the breach; and wherever a bone being luxated, is left unreduced, a new socket, new periosteum, new ligaments, and new bursæ, are formed out of the common cellular substance: and though the tendons may have been torn away from the head of the bone, they are fixed again, taking a new hold upon the bone.

8. There are other LIGAMENTS of a JOINT which prevent its luxation, guarding it at its sides, or round all its circle, according to its degree of motion; and those ligaments are of the same nature with the first, or bursal ligaments arise like them, from the periosteum chiefly, or indeed are truly but a thickening of the bursal ligament at certain points.

The universal connexion of these parts is now sufficiently explained, since we have followed the several forms of cellular substance: 1st, Clothing the bones with a thick membrane, which, though insensible, and almost inanimate in its own nature conveys blood vessels, the means of life, to the bones, and is named periosteum: 2ly, The same periosteum, thickened and strengthened by the adhesion of surrounding parts, so as to form the capsules for the joints: 3dly, The tendon also continued from the periosteum, and not growing from the muscle, but merely joined to it: 4thly, We see that smaller tendon, expanded into a thinner tendinous sheet, as in the brawn of the leg where the ham-strings (whose expansion strengthens the knee-joint) go down over the muscles of the leg: 5thly, We see the perpendicular partitions of this fascia going down among the muscles, and dividing them from each other; and the cellular substance which lies under the fascia, and immediately surrounds the muscle, cannot be distinguished from the inner surface of the fascia itself: 6thly, And as for the bursæ, we see that they are formed wherever the tendon rubs over a bone. The upper surface of the bursa is formed by the tendon which rubs over the bone: the lower surface of the same bursa is formed by the periosteum of the bone which it defends: the sides are formed by the common cellular substance. Its cavity appears to be merely an enlarged cell: and the bursæ mucosæ and capsular ligaments are plainly of one and the same nature: their liquors are the same, they often open into one another naturally, or if not naturally, at least it is no disease, since no bad effects ensue.

I must now explain more fully the constitution and nature of all the less feeling parts: for what I have said might be thought to imply absolute insensibility and total exemption from disease or pain: whereas the sensibility of tendons, ligaments,

bursæ, and joints, stands on the same footing with the feeling of bones: they are insensible in health; not easily injured; entering slowly into disease; but their diseases are equally dreadful from their duration and from their pain: for by inflammation their organization is deranged, their healthy consistence destroyed, and their sensibility excited in a dreadful degree.

The tendons of animals have been cut or pierced with embowelling needles; they have been pinched with nippers, and torn and cauterized; they have been burnt with a lighted stick, while the creature neither struggled nor shrunk from the irritation, nor ever gave the smallest sign of pain. Oil of vitriol has been poured upon each of these parts belonging to a joint, and a piece of caustic has been dropped into its cavity, but still no pain ensued; nay, some have been so bold may I not say so vicious as to repeat these experiments upon the human body, pinching, pricking, and burning the tendons of the leg, and piercing them with knives in a poor man, whose condition did not exempt him from this hard treatment; who was ignorant of this injustice that was done to him, while his cure was protracted and he was made a spectacle for a whole city. Without such cruel and inhuman practices we do not want opportunities of knowing, that in the human body also, the tendons and bursæ have no acute feeling. When we cut open a fascia or tendinous membrane, there is little pain: (when as in amputation) we cut the ragged tendons even and neat, there is no pain: when we snip with our scissors the ragged tendons of a bruised finger to cut it off, the patient does not feel: when we see tendons of suppurated fingers lying flat in their sheaths, we draw them out with our forceps or touch them with probes without exciting pain. In the old practice of sewing tendons, there was some danger, but no immediate pain: when we cut down into the cavity of a joint, still the pain is but slight. In a luxation, there is comparatively little pain.* There is no pain when the ligament of the patella is broken away from the tibia, nor when the great Achillis tendon is torn. There is but little pain in the moments of those accidents which appear slight in the time, but which turn out to be the most dreadful sprains. Yet after rupture of the patella, the knee inflames and swells: after rupture of the Achillis tendon,

* I cannot let this pass without again entering a protest. The pain of a dislocation is excessive. It is the greatest which the ingenuity of man has invented as a torture, and so it is incorrect to say as above, that tendons have been pinched and torn without giving pain. In the joints the parts are endowed with a sensibility well adapted to be a check on undue exertion, admonishing us of that degree of violence which would be injurious to the structure. Yet they are certainly not sensible like the other parts of the frame, and very happily so, as then we could neither sit, stand, nor walk.

there is swelling and inflammation, with such adhesion of the parts as makes the patient lame ; after the slightest sprain, such inflammation sometimes comes on as destroys the joint. There is but little pain when we first make an opening into any joint ; yet it often brings on such pain and fever, that the patient dies. In short every thing conspires to prove ; that though in wounds of the less feeling parts, there is indeed future danger, there is no immediate pain. Still there are many accidents which prove to us, that even in health, the joints are not entirely exempted from pain : a smart stroke on the knuckles, or a blow on the elbow, or a fall upon the knee, are not perhaps the purest instances of feeling in joints ; for such blow may have hurt some external nerve ; but when a small moveable cartilage forms within the joint of the knee, though it be small and very smooth, and lodged fairly within the cavity of the joint, it often gets betwixt the bones, causing instant lameness ; the moment it causes this lameness, it brings dreadful pains : the pain, the lameness, and all the feeling of inconveniency subside the instant that this cartilage is moved away from betwixt the bones ; and the joint continues easy till this moving cartilage chances again to fall in betwixt the heads of the bones. Even the pain from a blow upon the knee, for example, is plainly within the joint, and is caused by the force with which the patella is struck down against the ends of the bones. What indeed is a sprain, but a general violence and twisting of all the parts which compose the joint ? These parts are of one common nature, and may be arranged and enumerated thus : a joint is composed of the heads of the bones swelling out into a broader articulating surface, and of a thin plate of cartilage, which covers and defends the head of each bone : sometimes of small and moveable cartilages which roll upon the bones, and follow all the motions of the joint, and like friction wheels in machines of human invention, abate the bad effects of motion. There are mucous glands, or rather mucous bags, which convey a lubricating fluid : and there is a bursal ligament which forms the purse of the joint, binds the bones together, contains the synovia, and prevents the surrounding parts from being caught in the joint : there are lesser ligaments on the outside of this, going along the sides of the joint, and passing from point to point : there are great tendons moving over the joint, and bursæ, or mucous bags, which accompany these tendons, and prevent the violence which their continual rubbing might do to the bones. * All these parts are of one constitution and nature ; we cannot say that they are insensible, for their feeling is only deferred : it is slow, but not the less severe. The eye

feels the instant that a mote falls upon it ; but the skin does not feel a blister till it has been some hours applied ; the ligaments and joints feel still less in the instant that any injury is done : but as the inflammation of the blister excites the feeling, and destroys the fabric of the skin, producing pain and derangement of its parts, the inflammation of joints, and of all the parts belonging to them, breaks up the organization of the part, evolves the feeling, and then in them also comes disease and violent pain. They are slow in entering into action, but once excited, they continue to act with a perseverance quite unknown in any other part of the system. Their mode of action, whatever it may be at the time, is not easily changed : if at rest, they are not easily moved to action, and their excessive action once begun is not easily allayed. The diseases are infinite to which these parts are subject. They are subject to dropsical effusions ; they are subject to gelatinous concretions : they are subject to slight inflammation, to suppuration, to erosions of their cartilages, and to exfoliation, of their bones, corresponding with the dropsies, suppurations, and mortifications of the softer and more feeling parts. Rheumatism is an inflammation round the joints, with a slighter effusion, which is soon absorbed : chronic rheumatism is a tedious and slow inflammation, with gelatinous effusions round the tendons, and permanent swelling and lameness of the joints. Gout, in a joint, is a high inflammation, with a secretion of earthy matter into its cavity. The inflammation of tendons is sprain : effusion of gelatinous matter round them is ganglion : suppurations in the tendinous sheaths is whitlow : the inflammation of bursæ is false white swelling, not easily distinguished from the true : the disease of the joint itself is either a dropsy, where the joint, though emptied by the lancet, is filled up again in a few hours, showing how continual, and how profuse, both the exhalation and absorption of joints naturally is ; or it is white swelling, which, next to consumption, is the most dreadful of all scrophulous diseases, which begins by inflammation in the joint itself, is marked by stiffness, weakness, loss of motion, and pain : which goes on through all the stages of high inflammation, dreadful pain, destruction of cartilages, enlargement of bones, suppurations and spontaneous openings of the joints ; which sometimes stops by an effusion of callus and concretion of the bones, forming a stiff joint, but which oftener ends in hectic fever, diarrhœa, morning sweats, and extreme weakness ; so that the patient dies, exhausted with fever and pain.

BOOK III.

OF THE JOINTS.

CHAP. I

JOINTS OF THE HEAD AND TRUNK

JOINTS OF THE HEAD AND SPINE.

ALMOST every thing relating to the heads and processes of the bones, and every proposition concerning the motions which they have to perform, has been already explained, anticipating much of the anatomy of the joints: and the principles of motion mentioned in describing the bones, shall form the chief propositions on which my descriptions of joints shall be arranged, seeking that method chiefly by which the joints may be easily and rapidly explained; for it is a subject on which volumes might be bestowed, and not in vain.

We may compare, in the following order, the chief motions of the head and trunk. The head is so placed upon the oblique surfaces of the atlas, that it cannot turn in circles; but at that joint all the nodding motions are performed. The atlas rests so upon the dentatus, that there all the turning motions are performed. The neck and loins have their vertebræ so loosely framed, with such perpendicular processes and easy joints, that there all the bending motions are performed, while the back is fixed, or almost fixed, by its connexion with the ribs and by the obliquity and length of its spines; and though, upon the whole, the spine turns many degrees, yet it is with a limited and elastic motion where the whole turning is great, but the movement of each individual bone is small.

To secure these motions, we find, 1. The occipital condyles received into hollows of the atlas, where the oblique position of the condyles secures the joint, the occipital condyles looking outwards, the articulating surfaces of the atlas looking towards each other, the occiput set down betwixt them, so as to be secured towards either side, and the obliquity of the joint

being such withal as to prevent the head from turning round. These joints of the occiput with the atlas, are like the greater joints of the body, secured with regular capsules, or bag-like ligaments for each condyle, each rising from a rough surface on the vertebræ, and being fixed into a roughness at the root of the condyle. 2. We find a flat membranous ligament, which extends from the ring of the atlas to the ring of the occipital hole, closing the interstice betwixt the occiput and the atlas: it is confounded at the sides with the capsules of the articulating processes; is very strong before; and at the middle short point of the atlas it seems a distinct ligament, which is strong only at this point, and very lax and membranous behind.* 3. We find the atlas tied to the dentatus, by a more complete order of ligaments. These are, 1st, (as betwixt the atlas and dentatus,) regular capsules, or bags, fixing the condyles of one vertebræ to the condyles of the other. 2dly. A cross ligament† which, crossing the ring of the first vertebræ makes a bridge, embraces the neck of the tooth-like process, and ties it down in its place. 3dly, A smooth and cartilaginous surface all round the root of the tooth-like process, where this tooth of the dentatus turns in the ring of the atlas, and is bound by the ligament; and this rolling of the atlas upon the axis of the dentatus is so fair and proper a joint, that it also is all included in a capsular ligament. 4thly, The point of the tooth-like process having threaded the ring of the atlas, almost touches the occipital hole; and there another ligament ties it by its point to the occipital hole.‡

All the other vertebræ have another kind of articulation: to which the occiput, atlas, and dentatus are the only exceptions, for their motions are particular, and quite different from the rest. The atlas and dentatus bend, turn and roll by connexions resembling the common joints of the body; but the other vertebræ are united, each by its INTERVERTEBRAL SUBSTANCE, to the bones above and below; they are also united by their articulating processes to each other: each articulating process is held to another by a distinct capsule; each inter-

* This is part of what Winslow called *LIGAMENTUM INFUNDIBILIFORME*, a FUNNEL-LIKE LIGAMENT, joining the first vertebræ to the occiput.

† Viz. *LIGAMENTUM TRANSVERSALE*, or *TRANSVERSUM*: and what are called the APPENDICES of the TRANSVERSE LIGAMENT, are merely its edges, extending upwards and downwards, to be fixed into the dentatus, and into the occipital hole, so as to enclose the tooth-like process of the dentatus in a capsule.

‡ There are two flat ligaments which come from about the neck or root of the tooth-like process, and which go obliquely upwards, to be fixed into the groove just behind the lip of the occipital hole; but the ligament from the point of the tooth-like process is not what it has been supposed, a fair round ligament of some strength; there is nothing more than a few straggling fibres of ligament going from the point to the occiput, though Eustachius has drawn it round and strong.

vertebral substance is secured, bound down, and strengthened by strong ligaments ; for the intervertebral substance, which of itself adheres very strongly to the periosteum, and to the rough socket-like surface upon the body of each vertebra, is further secured by a sort of cross ligament, which go from the rim or edge of one vertebra to the edge of the next, over the intervertebral substance ; and so, by adhering to the intervertebral substance, they strengthen it. These ligaments cross each other over the interstice betwixt each vertebra, and are very strong. They are very regular, beautiful, and shining, and are named **INTERVERTEBRAL LIGAMENTS**.

The spine is further secured by a general ligamentous or tendinous expansion, which goes over the foreparts of all the vertebræ, from top to bottom of the spine. It begins at the forepart of the atlas ; it almost passes the body of the dentatus, or is but very slightly attached to it. It is at first pointed small and round ; it begins to expand upon the third vertebra of the neck, so as to cover almost all its body. It goes down along the bones, chiefly on their foreparts, and is but little observed on their sides. It is weaker in the neck, where there is much motion : stronger in the back, where there is none ; weaker again in the loins where the vertebræ move ; but still on the bodies of all the vertebræ it is seen white, shining, and tendinous. We can distinguish all along the spine interruptions and fasciculi, or firmer bundles going from piece to piece of the spine ; which fasciculi are indeed very seldom continued without interruption, further than the length of two or three vertebræ ; yet the whole is so much continued, that is if considered as one uninterrupted sheath, and is called the **EXTERNAL OR ANTERIOR VAGINA OR LIGAMENT OF THE SPINE**.*

But still the canal of the spine were left open and undefended, rough and dangerous to the spinal marrow, if internal ligaments were not added to these. The rings of the vertebræ are held at a considerable distance from each other by the thickness of the intervertebral substance, and by the corresponding length of the oblique processes ; but this space is filled up by a strong flat ligament, which goes from the edge of one ring to the edge of another, and so extending from the articulating processes, backwards to the spinous processes, they fill up all the interstice, complete the canal of the spinal marrow, and bind the bones together with great strength : † these are assisted in their office of holding the vertebræ to-

* The **LIGAMENTUM COMMUNE ANTERIUS, FASCIA LONGITUDINALIS ANTERIOR, FASCIA LIGAMENTOSA, &c.** It is from this ligament in the loins that the crura diaphragmatis arise, with tendons flat and glistening like the ligament itself, and hardly to be distinguished from it.

† They are named the **LIGAMENTA SUBFLAVA CRURUM PROCESSUUM SPINOSORUM**.

gether, by a continuation of the same ligament, or of a ligamentous membrane connected with it, which runs all the way onwards to the ends of the spinous processes, where they are strengthened by accidental fasciculi ;* and in the middle vertebræ of the back, but not of those of the loins or neck, similar ligaments are found also betwixt the transverse processes.†

Next, there is another internal ligament, which is not interrupted from bone to bone, but runs along all the length of the spine within the medullary canal, and it corresponds so with the external vagina, or anterior ligament of the spine, that it is called the POSTERIOR OR INTERNAL ligament.‡ It begins at the occiput, lies flat upon the back part of the bodies of the vertebræ ; at the interstice of every vertebræ it spreads out broad upon the intervertebral substance, doing the same office within that the intervertebral ligaments do without. It is broader above ; it grows gradually narrower towards the loins. Although it is called a vagina or sheath, it does by no means surround nor enclose the spinal marrow, but is entirely confined to the covering of the bodies of the vertebra, never going beyond the setting off of the articulating surfaces, or the place where the nerves go out. It adheres firmly to the bones, and does not belong at all to the spinal marrow. It should rather be called a ligament for the bones, than a sheath for the medulla. The anterior ligament prevents straining of the spine backwards : this one prevents the bending of the spine too much forwards, and they enclose betwixt them the bodies of the vertebræ, and their intervertebral substances.

There is yet a third internal ligament, which belongs entirely to the neck ; it is called APPARATUS LIGAMENTOSUS COLLI ; it begins from the edge of the occipital bone, descends in the canal of the vertebræ, is thin and flat, and adheres firmly to the body of each vertebra, covering the tooth-like process. The irregular fasciculi, or bundles of this ligament, stretch from bone to bone ; and the whole of the apparatus ligamentosus extends from the edge of the occipital hole to the fourth vertebra of the neck, where it ends. Its chief use is also as a ligament, merely fixing the head to the neck. The dura mater is within these, immediately enclosing the spinal marrow. The ligaments which I have just named, may be well enough allowed to be “at once ligaments for the bones, and a sheath for

* These are named the MEMBRANÆ INTERSPINALES LIGAMENTA APICES SPINARUM COMITANTES. The ligaments which tie the points of the spines, running from point to point, make a long ligament, which stretches down all the spine.

† Called LIGAMENTA PROCESSUM TRANSVERSORUM, and found only from the fifth to the tenth vertebra of the back

‡ FASCIA LIGAMENTOSA POSTICA, FASCIA LONGITUDINALIS, POSTICA, LIGAMENTUM COMMUNE POSTERIUS.

the medulla." But there is no such sheath as that called *ligamentum infundibiliforme* by Winslow ; for either they are peculiar and distinct ligaments for the bones, such as I have described, or they belong exclusively to the medulla, as the *dura mater*, which is indeed strengthened at certain points, into the thickness of a ligament ; but the only close connexion of the spinal marrow with the ligaments of the spine, is just at the hole of the occipital bone ; and for a little way down through all the rest of the spine, the connexion is by the loosest cellular substance.

OF THE LOWER JAW.

The LOWER JAW, is by its natural form, almost a strict hinge, and the lateral motion in grinding is but very slight. The joint is formed by a deep hollow or socket in the temporal bone, by a ridge which stands just before the proper socket, at the root of the zygomatic process, and by a long small head, or condyle, which is placed across the long branch, or condyloid process of the jaw. These form the joint and the condyle, the hollow of the temporal bone, and the root of the zygomatic process, are all covered with articulating cartilage. The joint is completed by a capsule of the common form, which arises from the neck of the condyle, and which is so fixed into the temporal bone as to include both the proper socket and the root of the zygomatic process. Thence it is manifest, that in the motions of the jaw, this transverse ridge is required as a part of its articulating surface ; that the common and lesser motions are performed by the condyle moving in the deepest part of its socket ; that the larger and wider openings of the mouth are performed by such depression of the jaw as makes its condyle mount upon the root of the zygomatic process. While the luxation of the jaw is a starting forwards of the condyle, till it is lodged quite before and under the zygomatic process, and the condyle standing upon the highest ridge, is the dangerous position in which luxation is most easily produced.

To render these motions very easy and free, a moveable cartilage is interposed. We find such cartilages in the joints of the clavicle, wrist, knee, and jaw, because the motions are continual and rapid. The moveable cartilage is thin in its centre, and thicker towards its edges, by which it rather deepens than fills up the hollow of the joint. It corresponds in shape with the head or condyle of the jaw, and with the hollow of the temporal bone. It moves with every motion of

the jaw, facilitates the common motions, and prevents luxation ; but the joint is still more strongly secured by the strength of its peterygoid and temporal muscles, which are inserted close round the joint, than by any strength of its capsule. It is the muscles which prevent luxation ; and it is their action also that makes luxation, when it has happened, so difficult to reduce.

RIBS.

The ribs have two joints, and a hinge-like motion, rising and falling alternately, as we draw in or let out the breadth. The two joints of the ribs are thus secured : First the proper head of the ribs being hinged upon the intervertebral substance, and touching two vertebræ, it is tied to the bodies of each by a regular capsule ; the bag is regular, is lubricated within and is as perfect as any joint in the body ; it is radiated without, so as to expand pretty broad upon the sides of the vertebræ, and has a sort of division, as if into two fasciculi, the one belonging to the vertebra above, the other to the vertebra below : they gradually vanish, and mix with the periosteum upon the bodies of the vertebræ, these are named *LIGAMENTUM CAPITELLI COSTARUM*, as belonging to the little heads of the ribs.

The back of the rib touches the forepart of the transverse process, and is articulated there : consequently there is a small capsular ligament belonging to this joint also ; but this joint is further secured, by two small ligaments, which come from the transverse process of the vertebra, and take hold on the neck of the rib : one short ligament coming from the point of the transverse process, is behind the rib, and is thence named *LIGAMENTUM TRANSVERSARIUM EXTERNUM* ; another, rather longer, comes from the inner face of the transverse process, goes a little round the neck of the rib, is implanted into the lower edge of the rib, and is named *LIGAMENTUM TRANSVERSARIUM INTERNUM* : another small ligament exactly opposite to this, going into the neck of the rib, upon its back part is also very regular ; and other subsidiary ligaments from different points assist these or supply their place.

The ribs are fixed into the sternum by their cartilages, each of which has a round head, a distinct socket, a regular capsule, and ligaments which expand upon the surface of the sternum, much in the same way that the *ligamenta capitelli* expand upon the bodies of the vertebræ : a tendinous membrane also binds the cartilages of the ribs, one to another, crosses over the interstice, and so covers the intercostal muscles with a sort

of fascia ; and the whole surface of the sternum and that of the cartilages is covered with this tendinous expansion, which belongs, confusedly, to the origins of the pectoral muscles, to the ligaments of the ribs and sternum, and to the periosteum of that bone.

CHAP. II.

JOINTS OF THE SHOULDER, ARM, AND HAND.

CLAVICLE.

THE joining of the clavicle with the sternum is the hinge upon which the whole arm moves, and is the only point by which the arm is connected with the trunk : the round button-like head of the clavicle rolls upon the articulating surface of the upper bone of the sternum : it is in such continual motion, that some particular provision is required ; and accordingly it has like the condyle of the jaw, a small moving cartilage, which rolls betwixt this head and the sternum. The cartilage is thin, and of a mucous nature : it is moveable in some degree yet it is fixed by one edge to the head of the clavicle. This joint is enclosed in a strong capsule, consisting first of a bag, and then of an outer order of fibres, which go out in a radiated form, upon the surface of the sternum, like the ligaments of the ribs ; and they cross and cover the sternum, so that the ligaments of the opposite side meet ; and this meeting forms a cord across the upper part of the sternum, which is named **INTERCLAVICULAR LIGAMENT**. Thus is the clavicle fixed to the sternum, and another broad ligament also ties it to the first rib.

The joining of the clavicle with the scapula is by the edge of the flat clavicle touching the edge of the acromion processes with a narrow but flat articulating surface : both surfaces, viz. of the acromion and of the clavicle, are covered with a thin articulating cartilage ; in some subjects a moveable cartilage is also found here : it is a regular joint, and is very seldom obliterated ; yet its motion, though continual, is not very free ; it is rather a shuffling and bending of the scapula upon this bone, favouring the play of the other joints ; it is secured first by a capsular ligament, which is in itself delicate and thin, but which is strengthened by many ligamentous bands, which pass (over the capsule) betwixt the clavicle and the acromion pro-

cess ; the clavicle, as it passes over the point of the coracoid process, is tied down to it by ligaments of considerable strength ; one comes from the root of the coracoid process to the clavicle, and is called *LIGAMENTUM COMMUNE CONOIDES* ; another from the point of the coracoid process, is implanted into the lower or inner edge of the clavicle, and is named *LIGAMENTUM COMMUNE TRAPEZOIDES* ; trapezoid, on account of its square form, and commune, because it goes from the scapula to the clavicle ; while other ligaments, going from one process of the scapula to another, are named proper or peculiar ligaments of the scapula. The *LIGAMENTUM PROPRIUM TRIANGULARE* stretches from the coracoid process to the acromion process of the scapula. The *LIGAMENTUM SCAPULÆ PROPRIUM POSTERIUS* is of less importance, being that which completes the notch of the scapula into a hole, and gives attachment to the omohyoideus muscle.

SHOULDER-JOINT.

THE SHOULDER is one of the most beautiful joints, loose and moveable, very free in its motions, but very liable to be displaced. To form this joint, the humerus has a large round and flattened head ; the cavity of the scapula,* which receives this head, is oval, or triangular, small and very shallow ; it is eked out with a thick cartilaginous border, which encreases the hollow of the socket, but still it is so shallow, that the humerus cannot be so much said to be lodged in the glenoid cavity as to be laid upon it. Its capsule or bag is very loose and wide, coming from the edges of the glenoid cavity, and implanted round the neck of the bone : the joint is richly bedewed with mucus, or rather with a mixed secretion, which is partly secreted by a fimbriated organ, consisting of lacunæ or bags, the common organ for this secretion through all the joints, and by a thinner exudation from those extreme arteries, which terminate, with open mouths, upon the internal surface of the bag.

By the shallowness of its socket, and the largeness of its head, by the looseness of its capsule, by all the forms and circumstances of its structure, the shoulder is exceedingly loose, and very liable to be displaced : it has this loose structure, and superficial socket, that its motions may be free, but seldom is there any great advantage gained in the human body, without a counterbalance of weakness and danger ; and every where in the limbs we observe that a joint is weak and liable to luxa-

* It is called glenoid cavity, from the Greek name of a joint, and the name is not absolutely appropriated to the scapula.

tion in proportion as its motions are free and large. Yet the shoulder-joint is not without some kind of defence ; its socket is shallow, but it is guarded by the largest projecting processes in all the body, by the acromion projecting and strengthening it above, and by the coracoid process within ; its ligament is lax, easily torn, and useful rather for confining the synovia, and keeping the head of the humerus opposite to its proper cavity, than in securing the joint by any strength it has : therefore a ligament extends from the coracoid to the acromion process, (*LIGAMENTUM PROPRIUM TRIANGULARE SCAPULÆ*,) which completes the defences of the joint above, and at its inner side. The capsule is perforated by the long tendon of the biceps muscle, and the hole by which it enters is called *foramen ovale*, and on each side of this hole the ligament is much strengthened ; and there comes also from the point of the acromion process an additional ligament, which adheres to the capsule : but the circumstance from which the chief strength of the shoulder-joint is derived, is the insertion of the four muscles which come from the scapula close round the head of the bone, so that they adhere to the capsular ligament, pull it up to prevent its being checked in the motions of the joint, strengthen it by their thickness, for they are spread upon it : and the contraction of the muscles hold the humerus in its place ; their total relaxation (as in certain cases of weakness) suffers the humerus to drop away from the scapula, without any fall or accident, forming what we are accustomed to call a luxation of the humerus, from an internal cause ; and the shoulder cannot be luxated by a fall, without such violence as tears up the tendons of these muscles. We must add to this anatomy of the joint, that it is surrounded by numbers of *bursæ* or mucous bags : * one under the tendons of the *subscapularis* ; one under the short head of the biceps muscles ; one betwixt the coracoid process and the shoulder-bone ; and one under the acromion process of the scapula, exceedingly large : and these are so fairly parts of the joint, that very commonly they open into it with communications, either perfectly natural or at least not hurtful, either originally existing or formed by continual friction. It should also be remembered, that the long tendinous head of the biceps muscle comes from the margin of the socket, directly over the ball of the *os humeri*, and through the capsule, by the *foramen ovale*.

* Vide *Monro's* tables of the *bursæ mucosæ*, where all these parts are represented, the knowledge of which is so very useful for the surgeon. I have opened this great bursa under the acromion process, and let out four pounds of the peculiar mucus and gelatinous lumps, with which the diseased *bursæ* are commonly filled.

ELBOW.

The **ELBOW-JOINT** is formed by three bones ; the humerus, radius, and ulna : the ulna bends backwards and forwards upon the shoulder-bone ; the radius bends upon the shoulder-bone along with the ulna ; it always must accompany the ulna, but it also has a motion of its own, rolling in circles ; its round button-like head rolling continually with its edge upon a socket in the ulna, and with its flat face upon the tubercle of the humerus. The whole composes one joint, and is enclosed in one capsule ; the bones accompany each other in their luxations, as well as in their natural motions : the ulna is never dislocated without the radius being also displaced ; a circumstance which is but too little noticed, and, so far as I remember, hardly considered or known.

The radius and ulna are united principally by the **INTEROSSEOUS LIGAMENT**, which as it extends in the whole length of the bones, has great strength. Towards the elbow this ligament is deficient for a space, and it is perforated by vessels. The **CHORDA TRANSVERSALIS CUBITI** is an oblique lip of ligament which passes from the tubercle of the ulna obliquely downwards and across to the radius.

LIGAMENTS OF THE ELBOW-JOINT.

The general **CAPSULE** arises from the humerus, from both the tubercles, and all round the two hollows which receive the olecranon and coronoid processes of the ulna ; it is implanted again into the tip of the olecranon, and all round that sigmoid cavity which receives the lower end of the humerus, and all round the edge of the coronary process. It is also fixed round the neck of the radius ; comprehends, in one bag, the humerus, radius, and ulna ; and unites them into one joint, performing two motions, viz. flexion and extension by the ulna, and rolling by the radius ; the joint is lubricated by mucus* and by fat, which is found chiefly about the olecranon : and that the bones may be further secured, additional ligaments are spread out upon them, which are all without the common capsule of the joint lying upon it, and strengthening it at the necessary points.

1. There is the common capsule enclosing the whole. 2. It is the form of every hinge-joint (and this is one of the purest)

* The oil contained in the adipose membrane never exudes in the living body, and cannot lubricate.

to have its capsule strengthened at the sides : and the sides of this, the elbow joint, are strengthened by two fasciculi, or ligamentous heads, which coming from the tubercles of the humerus, spread a little upon the capsule, and adhere to it like part of its substance. One, from the outer condyle, spreads upon the neck of the radius, and sends a strong division to be attached to the rough spine of the ulna, which is near the lesser sigmoid cavity of the ulna. This is of course the EXTERNAL LATERAL LIGAMENT. Another ligament, from the inner condyle of the humerus, goes upon the inside of the capsule and strengthens it there : it is implanted in the prominence on the inner edge of the coronoid process of the ulna, and is named the INTERNAL LATERAL LIGAMENT.* The continual rolling motion of the radius requires a peculiar ligament, and this peculiar ligament of the radius is named LIGAMENTUM CORONARIUM, or ANNULARE, because it encircles the neck of the radius ; ANNULARE or ORBICULARE from its hoop or ring-like form : it is a very strong and narrow stripe or band, which arises from that part of the ulna where the radius rolls upon it, and surrounds the radius, making at least two thirds of a circle ; and so having turned over the neck of the radius, is inserted into the opposite side of the ulna. This is commonly described as a distinct ligament surrounding the neck of the radius, and having the common capsule, implanted into its upper edge : but, in truth, it is like the others, a thicker band of the common capsule, but with a distinction much more particular here by the contrast of the great thickness of the coronary ligament, and the extreme thinness of the capsule at the fore part : for the capsule of every hinge-joint is strong only at its sides ; other bands from the outer condyle, and from the coronary process of the ulna, strengthen this ligament of the radius, and are known by the name of ACCESSORY LIGAMENTS of the coronoid ligament, as the lateral ones are known by the name of ACCESSORY LIGAMENTS to the capsule.†

So that there is, 1. A complete capsule which encloses all the bones ; 2. Lateral ligaments which make the main strength of the joint ; 3. A coronary ligament which regulates

* I see another ligament behind the internal lateral ligament, viz. rising from the external condyles and inserted into the side of the olecranon. There are in truth two internal lateral ligaments, and their operation is not merely to confine the motion of the joint laterally, but to check the flexion and extension of the arm ; the one being made tense by the flexion, the other by the extension, of the fore-arm.

† But the capsule ought to be called *membrana capsularis* ; it is not a ligament, and these which are called accessory are proper ligaments. The ligament which is on the fore part of the joint, and which runs towards the *Ligamentum Annulare*, is properly called *Accessorium Annuli Anticum* ; it crosses from the ulna to the external condyle ; and another coming round from the olecranon, and being on the back of the joint, *Accessorium Annular Posticum*.

and strengthens the rolling motions of the radius, and keeps it firm, turning like a spindle in its bush. The whole joint is surrounded with a cellular substance: the regularity of its ligaments is confounded by the adhesions of muscles and tendons: though it is, on the whole, weak behind and before, and very strong at its sides, yet tendinous and ligamentous fibres cross it in all directions: so that the capsule and its assisting ligaments are irregular and rough without; but gelatinous, smooth, and glossy within.

WRIST.

The WRIST is one of the most moveable joints in the body, having the strength of a mere hinge-joint; (because it is almost a strict hinge, by the connexion of the long ball of the carpus with the long hollow of the radius,) and having at the same time, all the properties of the most moveable joint by the free turning of the radius, without the weakness which is peculiar to the circular and free moving joints. These distinctions divide the wrist-joint into its two parts.

1. The articulation formed by the scaphoid and lunate bones, which form an oval ball of articulation, and the great scaphoid cavity of the radius which receives this ball; the end of the ulna does not properly enter into the cavity of the wrist but its end, or little round head, is covered with a moveable cartilage, and that cartilage represents the end of the ulna. It is called *CARTILAGO INTERMEDIA TRIANGULARIS*. Now, this first joint, viz. of the scaphoid and lunate bones, the head of the radius, and the moveable cartilage which represents the head of the ulna, are surrounded by the general capsule or bag of the joint. The capsule arises from the ends of the radius and of the ulna; from the styloid point of the one, round to the same point of the other; and is implanted near the lower rank of the carpal bones; though it adheres first to the scaphoid and lunate bones, it passes them, going over all the bones of the carpus, especially in the palm, so as to add strength to their peculiar ligaments; and in the palm, the tendons for the fingers run over it; so it forms on one side an additional ligament for the capus; on the other, it forms the floor of the tendinous sheath, a smooth and lubricated surface for the tendons to run upon. This general ligament is strengthened by particular ones coming from the styloid processes of the radius and of the ulna, which spread upon the bones of the carpus, and may be described as lateral

ligaments; for although the wrist joint is not accurately a hinge, yet it partakes most of that character, and the ligaments are strongest at the radial and ulnar edges of the wrist. But there are so many irregular points of bone about the wrist, that the little fasciculi, with which this capsule is covered and strengthened, are innumerable. Within this joint, and stretching from the groove betwixt the scaphoid and lunate bones, there is an internal ligament of a soft and pulpy nature; it is named *LIGAMENTUM MUCOSUM*; but the very name shows that it is less valuable as a ligament (since the joint is already well enough secured,) than as a conductor for the lacunæ or ducts which separate the mucus.

2. The articulation by which the hand performs all its turning motions is that of the radius with the ulna; this is set apart altogether from the general articulation of the joint. The lateral cavity of the radius receives the little round head of the ulna; they are enclosed in their own peculiar capsule, which is so loose about the bones, that although it is a regular capsule of the common form, it has the name of *MEMBRANA CAPSULARIS SACCIFORMIS*. Thus there is one joint within another a moveable cartilage betwixt them, and the capsule of the one, the more moveable joint, peculiarly wide, and not so strong; all which should be considered in thinking about luxations of the wrist.

The carpal bones are connected with each other so very closely, that the name of joint can hardly be used. They are rather fixed than jointed together. Each bone has four smooth articulating surfaces, by which it is united to the adjoining bones. The first two bones form the great ball of the wrist; the second row again is united with the first, by a sort of ball and socket; for the *os magnum*, which is the central bone of the second row, has a large round head, which is received into the lunate hollow of the *os lunare*, which is the central bone of the first row. The first row is thus united to the second, by a distinct and general capsule, in addition to which each single bone is tied to the next adjoining, by a regular capsular ligament within, and by flat cross ligaments without, or rather by many bundles of ligaments, which cross each other in a very complicated manner, and the little flat and shining fasciculi give the whole a radiated or star-like form.*

The metacarpal bones are also joined to the carpal in one

* These are the ligaments which are really so unimportant to the anatomist, or to the surgeon, but which are so laboriously described under the titles of *LIGAMENTA BREVIA, OBLIQUA TRANSVERSARIA*, and *PROPRIA OSSIUM CARPI*; for they do in fact cross and traverse the carpus in every possible direction.

row by a line of joints, which are as one joint; besides their common capsule, the metacarpal of each finger has its peculiar ligaments proceeding in a radiated or star-like form from the carpal bones, and going out broad upon the metacarpal bones, and so numerous, that each metacarpal bone is securely tied by ligaments to one or two of the bones of the carpus;* and at their heads, where the fingers are implanted upon them, forming the knuckles, they are again tied by flat ligaments, which go from head to head of the metacarpal bones,† binding them together, permitting a slight bending towards each other, so as to make a hollow in the hand, but no such wide motion as might assist the fingers; they are but as a foundation upon which the fingers stand and move.

FINGERS.

The joints of the fingers are formed by round heads in the upper end of one row of bones, and by hollow sockets on the lower ends of the next row; each joint is qualified by the round form of its heads, to be a circular and free moving joint; but it is restricted by the forms of its ligaments, to the nature of the hinge-joint; for each finger-joint is included first in a fair round capsule, or bag of the ordinary form, but that capsule is strengthened by very distinct lateral ligaments upon its sides, which lateral ligaments form the chief strength of the joints; above these lateral ligaments the joint is strengthened by a broad fascia, or sheath, which comes from the tendons of the interossei muscles, covers the backs of all the fingers, which is especially strong over the joints. One part of the apparatus of the wrist-joint is the smooth and lubricated SHEATH, in which the tendons of the fingers run. It is formed in part by the outer side of the capsule of the wrist, and in part by that bridge of ligament which proceeds from the four corner points of the carpal bones. This sheath is lined with a delicate and softer modification of the common tendinous membrane, is fully bedewed with mucus, and is fairly to be ranked with the bursæ mucosæ, as it is indeed, like them a shut sack. But it is farther crossed in such a manner by partitions belonging to each flexor tendon, that each of them may be said to have its appropriated bursa mucosa. And these bursæ, to prevent the bad consequences of friction, are put both betwixt the cross ligament and the tendons, and also betwixt the tendons of the upper-

* And these also are named according to their several directions, *LIGAMENTA ARTICULARIA, LATERALIA, RECTA PERPENDICULARIA, &c.*

† These are named the *LIGAMENTA INTEROSSEA*.

most muscle, and of the deeper one, and again betwixt the tendons of the fingers and of the thumb.

In the same way the sheaths of the tendons, as they run along the fingers, may be considered as part of the apparatus of their joints; for the first set of bursæ, viz. those which lie in the palm of the hand, stop before they reach the first joints of the fingers, and then other longitudinal bursæ begin from the first joint of the fingers, and go all along them to the last joint forming the sheath for the tendons to run in, which does at once the office of a strong ligament, binding them down in their places, and which is so lubricated on its internal surface, as to save the necessity of other bursæ. These sheaths are thicker in certain points, so as to form cross rings of strong ligament; but the common sheath, and these thicker rings, still form one continued canal; these are named the SHEATHS and ANNULAR LIGAMENTS, or CROSS LIGAMENTS* of the fingers, and are of the same nature with the bursæ. Besides these, there are no distinct bursæ on the fingers, but there are several about the wrist, and one especially of a considerable size at the root of the thumb.†

CHAP. III.

JOINTS OF THE THIGH, LEG, AND ANKLE.

OF THE HIP-JOINT.

THE acetabulum, which is rough in the naked bone is naturally lined with a thick and very smooth cartilage. The head of the thigh-bone is covered with a similar cartilage, also very thick and smooth; and these cartilages almost fill up that deep dimple which is seen in the centre of the head of the thigh-bone, and smooth that hole, which is formed in the centre of the socket by the meeting of the several pieces of which it is composed. The socket is not only deep in its bones, but is further deepened by the cartilage which tips the edge of the socket and which stands up to a considerable height. The socket is imperfect at that side which looks towards the thyroid hole; the bony edge is entirely wanting there, and the space

* LIGAMENTA VAGINALIA, LIGAMENTA CRUCIATA, PHALANGUM, &c.

† Vide Monro's Bursæ Mucosæ.

is filled up by a strong cartilaginous ligament, which goes across this gap, from the one point to the other, and from its going across is named the *LIGAMENTUM LIBRI CARTILAGINÆI TRANSVERSALE*.* The capsular ligament of the hip-joint is the thickest and strongest of all the body. It is, like other capsules, a reflection and thickening of the periosteum; the periosteum coming along the outside of the bone, leaves it at the edge of the socket. The periosteum, or rather perichondrium from the inside of the socket, comes up to the edge, and meets the out layer. They unite together, so as to form the general capsule enclosing the ring-like cartilage, which tips the edge of the socket between them. This ligament encloses all the bones from the edges of the socket to the roots of the trochanters, embracing not only the head, but the neck of the thigh-bone. The outer plate, continues with the periosteum, is thick and strong, and is assisted by much cellular substance condensed round it, and it is further thickened by slips which come from the iliacus, glutæus, and other muscles which pass over the joint, while the external plate of the ligament lines the whole with a soft and well lubricated coat.

In addition to this general capsule, there are two internal ligaments, 1st, The round ligament, as it is called, which comes from the centre of the socket to be fixed into the centre of the ball of the thigh-bone. it is not round, but flat or triangular. It has a broad triangular basis, rooted in the socket exactly at that place where the several bones of the socket meet, forming a triangular ridge, which gives this triangular form to the central ligament. It has three angles, and three flat sides. It is broad where it arises from the bottom of the socket, is about an inch and a half in length, grows narrower as it goes outwards towards the head of the bone, and is almost round where it is implanted into the dimple in the head of the thigh-bone, at which point it is so fixed, as to leave a very remarkable roughness in the naked bone. But round the roots of this ligament, and in the bottom of the socket, there is left a pretty deep hollow, which is said to filled up with the synovial gland. It is wonderful how easy authors talk of the synovial gland, as if they had seen it; they describe very formally its affections and diseases, as when hurt by a blow upon the trochanter; yet there is no distinct gland to be found. There is a fringed and ragged mass lodged in the bottom of the socket, hanging out in the hollow, and continually rubbed by the ball of the thigh-bone in its motions: the fringes and

* This ligament is double, that is, there is one on the inside of the edge, and one on the outside; thence it is often reckoned as two ligaments, viz. *LIGAMENTUM TRANSVERSALE INTERNUM* et *EXTERNUM*.

points, certainly are ducts from which we can squeeze out mucus; but it is by no means proved that they belong to a synovial gland, and it looks rather as if the ducts were themselves the secreting organ, like the lacunæ, or mucous bags in the tongue, or in the urethra, vagina œsophagus, and other hollow tubes. Such a structure is fitter for suffering the strong pressure and continual action of the thigh-bone, than any determined gland. We see, then, nothing but mucous ducts of a fringed form, hanging down from this hollow into the cavity of the joint, a quantity of fat accompanying these fringes, and a pappy mucous membrane, which keeps these fringes and fatty membranes orderly, and in their places, and which ties them so to the angles of the triangular ligament, that they must move with the motions of the joint. This mucous membrane, which keeps these fatty fringes orderly, has two or three small bridles in different directions, whence they are named the *LIGAMENTA MUCOSA*, or *ligamentula massæ adiposæ glandulosa*; and this may be considered as the continued inflection of the softer internal lamella of the capsule, which not only lines the socket, but is reflected over the central ligament, and over the globe of the thigh-bone, covering them also with a delicate mucous coat. Other fringes of the same kind are found at the lower part of the joint, lying round the neck of the thigh-bone near the angle where the capsular ligament is implanted into the root of the great trochanter: the liquor from these mucous fimbriæ, with the general serous exudations, are mixed and blended for lubricating the joint.

This capsule, which is naturally the thickest and strongest in the body, almost a quarter of an inch in thickness, is farther strengthened by many additions: for a slip of very strong tendinous or cellular substance condensed, comes down from the lower spinous process of the os ilium, and spreads out over the capsule, and strengthens it very much on its forepart; the smallest of the *glutæi* muscles adheres to the capsule, and strengthens it behind; the *psoas magnus* and *iliacus internus* pass by the inner side of the capsule, and though they do not absolutely adhere to it, they deposit much cellular substance, which is condensed so as to strengthen the capsule, forming at the same time a large *bursa mucosa*, betwixt their tendinous fibres and the joint. That tendon of the *rectus* muscle which comes from the margin of the socket, lies upon the outer side of the capsule, adheres to it, and strengthens it. The security of the hip-joint seems to depend more upon the strength of its capsular ligament, than that of almost any other joint.

THE KNEE-JOINT.

The knee-joint is one of the most superficial joints and one of the weakest, so far as relates to the bones, for the flat condyles of the thigh-bone are merely laid upon the flat head of the tibia. There is here no fair cavity, receiving a large head as in the joint of the hip; no slighter ball and socket, as in the fingers; no strong over-hanging bones, as in the shoulder; no hook-like process, as in the ulna. This is not a hinge joint, like the ankle, secured between two points of bone. We do not find the means of strength in its bones, but in the number, size, and disposition of the great ligaments with which its bones are joined; by virtue of these ligaments it is the strongest joint of the human body, the most oppressed by great loads, the most exercised in continual motions, yet less frequently displaced than any other. But this complication of ligaments, which gives it mechanical strength, is the very cause of its constitutional weakness, makes it very delicate, and very liable to disease.

The bones which compose this joint are the tibia, thigh-bones, and patella; and they are united by many ligaments, both within and without the joint.

1. The CAPSULE of the KNEE is naturally very thin and delicate, transparent as a cobweb. This thin capsule comes from the forepart of the thigh-bone, all round the articulating surfaces, whence it goes downwards by the sides of the condyles; from this origin it is inserted into all the edge of the rotula, and in such a way as to keep the rotula properly without the cavity of the joint, the capsular ligament going over its inner surface, and lining it with a smooth and delicate coat. It is fixed below into all the circle of the head of the tibia, and thus completes its circle, embracing all the bones. This capsule, naturally so thin and delicate, is made up from all the surrounding parts to a considerable thickness; first, it is covered behind by the heads of the gastrocnemii: at the sides, by the biceps, and other muscles of the ham-strings; on its forepart, it is strengthened by the general fascia of the thigh, which goes down over the knee, and being there re-enforced both by its adhesion to the bones, and by the broad expansion of the vastus internus, sartorius, biceps, and other muscles, which go out over the patella, it adheres to the capsule, and makes the whole very strong; besides which, there is a ligament, which, lying in the ham, upon the back part of the capsule, is named, in compliment to Winslow, **LIGAMENTUM POSTICUM WINSLOWII**. It is a ligament somewhat

resembling the lateral ligaments of the elbow. It arises from the outer condyle, goes obliquely across the back part of the joint, adheres to it, and strengthens it; but often it is not found at all, or in such straggling fibres as cannot be accounted a ligament.* It is manifest that the knee requires some such additional ligaments behind, to serve as a check, and to prevent its yielding too far.

2. The knee, as being a hinge-joint, has strong ligaments at the sides, and here the lateral ligaments are particularly distinct, and can be raised from the capsule; on the inner side of the joint, there comes down from the internal condyle of the thigh-bone, a broad flat ligament, which is fixed into the inner head of the tibia, and is named the internal lateral ligament; on the outside of the knee, there descends from the tip of the outer condyle a much stronger ligament, not quite so flat, rather round: it extends from the condyle of the thigh-bone to the bump of the fibula which it embraces. It is a little conical from above downwards; it is from two to three inches in length, and is named *LIGAMENTUM LATERALE EXTERNUM LONGIOR*, to distinguish it from the next; for behind this first external ligament, there arises a little lower from the same condyle, along the outer head of the gastrocnemius muscle, a ligament which is called the *LIGAMENTUM LATERALE EXTERNUM BREVIOR*, and it is not shorter only, but so sparse as not to be easily distinguished, not having the true form of a lateral ligament coming down from the condyle, but of a mere strengthening of the capsule, coming upwards from the knob of the fibula.†

3. The joint is still further secured by internal ligaments which are within the cavity of the joint; they are named the *CRUCIAL LIGAMENTS* of the knee. They arise betwixt the hollow of the condyles of the thigh-bone, and are implanted into the back part of the middle rising of the tibia: they lie in the back part of the joint, flat upon the back of the capsule, and the one crossing a little before the other (but yet in contact with each other, at the place of crossing;) they are distinguished by the names of *ANTERIOR* and *POSTERIOR CRUCIAL LIGAMENTS*.

The *POSTERIOR CRUCIAL* ligament is more perpendicular; it arises from the hollow betwixt the condyles of the thigh-bone, and is implanted into a roughness on the back of the tibia, betwixt its two cup-like hollows, and behind the tubercle which divides these hollows from each other. While the

* Often it is irregular, or in straggling fibres; but I have never found it wanting.

† Some strong, but irregular accessory ligaments go down to that part of the head of the tibia which is before the head of the fibula.

posterior arises rather from the internal condyle, the ANTERIOR LIGAMENT arises properly from the external condyle, passes obliquely over the tuber, in the articulating surface of the tibia, and terminates in the cup-like hollow. The effect of these two ligaments is more particular than is commonly observed; for the one goes obliquely out over the articulating surface of the tibia, while the other goes directly down behind the joint; and of course when the knee is bended, the posterior ligament is extended; when the leg is stretched out, the anterior ligament is extended; they both are checks upon the motions of the joint; the anterior ligament prevents the leg going too far forwards, the posterior ligament prevents its being too much bent back upon the thigh.*

4. The most admirable part of the mechanism of this joint, is the two SEMILUNAR CARTILAGES. They are so named from their semilunar form: they lie upon the top of the tibia, so as to fill up each of them one of the hollows on the top of that bone. They are thicker towards their convex edges, thinner towards their concave edges; they end by two very acute and long horns, named the CORNUA of the lunated cartilages. In short, they resemble the shape of the label which we put round a wine decanter; and the two horns are tied to the tubercle or ridge that stands in the middle of the articular surface of the tibia, and consequently they are turned towards each other, so as to touch in their points. There are here, as in the other joints, masses of fat enclosing the fimbriated ends of the mucous ducts. These fimbriæ and, fatty bundles, are formed chiefly round the circumference of the patella, commonly surrounding it with a complete fringe; they are also found at the back of the cavity, about the crucial ligaments, and in all the interstices of the joint; the fatty bundles filling up the interstices, protecting the mucous ducts from more violence than what is just necessary to empty them, and perhaps mixing their exudation with the mucus of the ducts.

These masses of fat lie covered by the delicate internal surface of the capsule, and the mucous fimbriæ project from it.

The inner surface of the capsule is so much larger than the joint which it lines, that it makes many folds or lurks, and several of these are distinguished by particular names. Thus, at each side of the patella there are two such folds, the one

* There is not attention enough paid to the origins of these ligaments from the femur; for it is the origin from the thigh-bone which determines their operation. The posterior ligament comes from the root of the internal condyle, and depth of the semilunar notch, anterior to the centre of motion of the lower head of the femur on the tibia; it is consequently stretched in extending the leg. The anterior ligament arises from the root of the external condyle, posterior to the centre of motion; it is consequently stretched in the flexion of the knee-joint.

larger than the other, whence they are named *LIGAMENTUM ALARE MAJUS*, and *LIGAMENTUM ALARE MINUS*. These two folds are like two legs, which join and form one middle fold, which runs across in the very centre of the joint, viz. from the lower end of the patella to the point of the thigh bone, in the middle betwixt the condyles. It keeps the looser fatty bundles and fimbriated ducts in their place, (viz. the hollow betwixt the condyles, where they are least exposed to harm;) thence it has been long named the *LIGAMENTUM MUCOSUM*. The internal membrane of the joint covers also the semilunar ligaments, as a perichondrium; it comes off from the ridge of the tibia, touches the horns of the semilunar cartilages, moves over the cartilage, so as to give them their coat, and at the point where it first touches the horns, it forms four little ligaments, two for the horns of each cartilage. These tags by which the four points of the lunated cartilages are tied, are named the *LIGAMENTA CARTILAGINUM LUNATARUM*, or more simply named the four adhesions of the lunated cartilages. There is a little slip of ligament, which goes round upon the forepart of the knob of the tibia, and ties the foreparts of these two cartilages to each other. It is named *LIGAMENTUM TRANSVERSALE COMMUNE*, because it goes across from the fore edge of the one cartilage to the fore edge of the other, and because it belongs equally to each; but for their further security, these cartilages also adhere to the outer circle, or thick edge, to the internal surface of the general capsule of the joint by the *ligamentum coronarium*, and that again adheres to the lateral ligaments which are without it; so that there is every security for these cartilages being firm enough in their places, to bear the motions of the joint, and yet loose enough to follow them easily.

This joint has the largest bursæ mucosæ of all, and these perhaps the most frequently diseased. There is one bursa above the patella, betwixt the common tendon of the extensor muscles and the forepart of the thigh-bone, which is no less than three inches in length. There is a smaller bursa about an inch below the patella, and under the ligament of the patella, protecting it from friction, upon the head of the tibia. These bursæ, I am persuaded, are often the seat of disease when it is judged to be in the joint itself. But the truth is very easily known; for if a swelling appear under the patella projecting at the sides, and raising the patella from the other bones, we are sure that it must be in the main cavity of the joint; but if swellings appear above and below the patella, then there is reason to believe that these belong to the great bursæ, which are placed above and below the patella, a

complaint which is far less formidable than a swelling of the joint itself: I would almost say, easily cured; for openings into these bursæ, though they should be avoided, are less dangerous than openings into the joint. It is from mistaking such tumours for collections in the capsule itself, that authors speak of openings into the joint as a familiar or easy thing, or think that they have done such operations safely, when probably they were puncturing the bursæ only.*

These bursæ mucosæ lie under the tendon of the extensor muscles, and under the ligament of the patella: they are of the same substance with the capsule of the joint itself: they lie over the capsule, united to it by cellular substance, and the bundles of fat which are disposed irregularly about the joint, belong partly to the bursæ and partly to the capsule; one end projecting into the cavity of the bursæ, while the other end of the same fatty bundles projects into the cavity of the joint.

Thus the knee-joint, which is the most important in all the body; the most oppressed by the weight of the trunk, and by the accidental loads which we carry; the most exercised in the common motions of the body, and the most liable to shocks and blows, which is the most superficial and the weakest in all that respects its bones, is the strongest in its ligaments, and the most perfect in all the provisions for easy motion.

1. The great CAPSULE of the joint encloses the heads of the bone, secretes (in part) and contains the synovia: lines the joint with a smooth and delicate membrane, and by turning over all the parts, and adhering to them, it forms the perichondrium for the cartilaginous heads of the bones, and the covering and ligaments for the moving cartilages of the joint.

2. This capsule, which is exquisitely thin, and which was formed for other uses than for giving strength to the joint, is surrounded on all sides with such continuations of the common fascia, and such particular expansions of the ham-string and other muscles, as by adding outwardly successive layers to the capsule, brings it to a considerable degree of strength.

3. The capsule having no stress upon its forepart, is very thin upon its forepart, viz. at the sides of the patella, but is strengthened at the sides by fair and distinct ligaments, going from point to point of the three great bones, and so large and particular as to deserve, more than any others in the body,

* I believe that the great bursæ and the joint always communicate largely; and that being consequently one continuous surface, the opening of the bursæ would be highly improper.

the name of **LATERAL LIGAMENTS** ; at the back part of the joint, the same strength is not required as at the sides ; yet it must be stronger than at its forepart, wherefore it is strengthened by the additional bands which are sometimes general and confused, but often so perfect and distinct, as to be known by the name of the **POSTERIOR LIGAMENT** of **WINSLOW** ; and as the lateral ligaments prevent all lateral motions, this strengthening of the capsule serves as a check-band behind.

4. It is only in the greatest joints that we find the additional security of **INTERNAL LIGAMENTS**, and the only joints where they are perfect, are the joints of the hip and of the knee ; the former having its round, or rather triangular ligament, which secures the great ball of the thigh-bone, and fixes it in its place ; the latter having its crucial ligaments, which, coming both from one point nearly, and going the one over the face of the tibia, and the other down the back of that bone, serve the double purpose of binding the bones firmly together, and of checking the larger and dangerous motions of the joint, the fore ligament preventing it going too far forwards, and the back ligament preventing it bending too much.

5. A **MOVING CARTILAGE** for facilitating motion and lessening friction is not common, but is peculiar to those joints whose motions are very frequent, or which move under a greater weight ; such are the inner head of the clavicle, the articulation of the jaw, and the joints of the wrist and of the knee ; and it is in the knee that the moveable cartilages have their most perfect forms and use, are large and flat semilunar, to correspond with the forms on the head of the tibia ; thicker at their outer edges to deepen the socket ; and though moveable, yet so tied with ligaments, as never to go out from their right place.

And, 6. The mucous follicular bundles of fat, and the *bursæ mucosæ*, which complete the lubricating apparatus of the joint, and the mucous *frenulæ* or ligaments, which both conduct the mucous fringes and keep them in their place, are more perfect in the knee, and greater in number and size, than in any other joint.

I may well call this the most complicated, and (by daily and melancholy proofs) it is known to be the most delicate joint of the body.

FIBULA.

The **FIBULA** is a support to the tibia in its various accidents ; it gives a broader origin to the muscles, and it is the chief defence of the ankle-joint. It has no motion upon the tibia ;

the best authors speak of it as a symphysis, which classes it with the joinings of the pelvis, and excludes it from the list of true and moveable joints. It is united with the tibia by a sort of flat cartilaginous surface upon either bone ; it is merely laid upon the tibia, not sunk into it. It is tied by a close capsule : it has no particular ligament for itself ; but is strengthened by the external lateral ligament of the knee, which adheres to this knob, and by the insertion of the biceps tendon, which is implanted into this point, and which spreads its expanded tendon over the forepart of the tibia, and holds the bones together ; and the firmness of the fibula is further secured by the great interosseous ligament, which goes from bone to bone. Towards the head of the bones the interosseous ligament is deficient.

ANKLE.

The ANKLE-JOINT owes less of its strength to ligaments than to the particular forms of its bones ; for while the strong lateral ligaments of the knee guard it so that it cannot be dislocated till they are torn, the lower heads of the tibia and fibula so guard the foot, that when luxated, these bones are often broken. First, the fibula is so connected with the tibia, at its lower end, that they form together one cavity for receiving the astragalus, with two projecting points, the fibula forming the outer ankle, and the tibia forming the process of the inner ankle ; the joining of the fibula to the tibia here, is like that of its upper end, too close to admit of the smallest motion and it is thoroughly secured by particular ligaments, one of which passing from the fibula to the tibia on the forepart, is named the *LIGAMENTUM SUPERIUS ANTICUM*, consisting, in general, of one or two distinct flat bands. Another more continued and broader ligamentous membrane goes from the fibula to the tibia across the back part, and is named *LIGAMENTUM POSTICUM SUPERIUS* ; the *LIGAMENTUM POSTICUM INFERIUS*, being but a slip of the same. Next comes the capsule of the joint, which joins the astragalus to the lower heads of the tibia and fibula ; it is thinner both before and behind, than we should expect from the strength of a joint which bears all the weight, and the most violent motions of the body. But, in fact, the capsule every where serves other purposes than giving strength to the joint, and never is strong, except by additional ligaments from without ; so it is with the ankle-joint, the capsule of which is exceedingly thin before ; but it is strengthened at the back part, and especially at the sides, by

supplementary ligaments: First, a strong ligament comes down from the acute point of the inner ankle, expands in a radiated form upon the general capsule; adheres to it, and strengthens it, and is fixed all along the sides of the astragalus to the os calcis and naviculare. This ligament, coming from one point, and expanding to be inserted into a long line, has a triangular form, whence it is named *LIGAMENTUM DELTOIDES*; and while the general ligament secures the joint towards that side, the oblique fibres of its fore edge prevent the foot being too much extended, as in leaping, and its oblique fibres on the back edge prevent its being too much bended, as in climbing; but the ligaments of the outer ankle, tying it to the outer side of the astragalus, are indeed distinct, one going forwards, one going backwards, and one running directly downwards; one goes from the point or knob of the fibula, obliquely downwards and forwards to be inserted into the side of the astragalus; it is square and flat, of considerable breadth and strength, and is called *LIGAMENTUM FIBULÆ ANTERIUS*. Another ligament goes perpendicularly downwards, from the acute point of the outer ankle, to spread upon the side of the astragalus, and of the capsule, and is finally inserted into the heel-bone, this is named the *LIGAMENTUM FIBULÆ PERPENDICULARE*. A third ligament goes out still from the same point, to go backwards over the back part of the capsule, adheres to the back of the capsule and strengthens it, and is named *LIGAMENTUM INTER FIBULAM ET ASTRAGALUM POSTERIUS*. There is nothing very particularly worthy of notice in the ankle-joint, for it is covered with cartilages, lined with a soft and mucous membrane, and lubricated with mucous fimbriæ and masses of fat, such as are found in all the joints. It is stronger than the other joints; it can hardly be luxated, without a laceration of its ligaments, and breaking of the bones which guard it at either side; and it is the great violence which is required for completing this dislocation, and the terrible complication of dislocation, fracture and laceration of the skin, which makes this accident so dangerous beyond any other luxation.

UNION BETWIXT THE BONES OF THE TARSUS.

The *ASTRAGALUS*, *OS CALCIS*, *OS NAVICULARE*, and all the bones of the tarsus, are united to each other by large heads, and have distinct and peculiar joints; besides which, the bones are cross-tied to one another by ligaments, so numerous and complicated, that they cannot nor need not be explained.

They pass across from bone to bone, in an infinite variety of directions, some longitudinal, some transverse, and some oblique. There is a curious complication, which we may call a web of ligaments, covering either side of the foot with shining and star-like bundles; each bone has its capsular ligaments for joining it to the next; each joint of each bone has its articulating cartilages always fresh and lubricated; each joint has, besides its capsule, flat strips of oblique, longitudinal, and transverse ligaments, joining it to the nearest bones, and the greater bones have larger and more important ligaments; as from the astragalus to the os calcis, from the os calcis to the os naviculare, and from that again to the scaphoid bone, &c.

The metatarsal bones have their capsular ligaments joining them to the tarsal bones, and they have ligaments strengthening their capsules, and tying them more strongly to the tarsal bones; and, as in the metacarpal bones, the several ranks are tied one to another by cross ligaments which pass from the root of one bone to the root of the next; so we have ligaments of the same description and use, holding the metatarsal bones together, both on the upper and on the lower surface of the foot; and all the ligaments of the foot are of great strength and thickness. The lower ends of the metatarsal bones have also transverse ligaments by which they are tied to each other. The toes have hinge-joints formed by capsules, and secured by lateral ligaments, as those of the fingers are; and, except in the strength or number of ligaments, the joinings of the carpus, metacarpus, and fingers exactly resemble the joinings of the tarsus, metatarsus, and toes.

But these ligaments, though helping to join the individual bones, could not have much effect in supporting the whole arch of the foot. It is further secured by a great ligament, which extends in one triangular and flat plate, from the point of the heel to the roots of each toe. This is named the **APOEURESIS PLANTARIS PEDIS**, which is not merely the aponeurosis for covering, defending, and supporting the muscles of the foot; that might have been done on easier terms with a fascia, very slight compared with this; but the chief use of the planter aponeurosis is in supporting the arch of the foot. It passes from point to point, like the bow-string betwixt the two horns of a bow, and, after leaping, or hard walking, it is in the sole of the foot that we feel the straining and pain; so that, like the palmar aponeurosis, it supports the arch, gives origin to the short muscles of the toes, braces them in their action, and makes bridges under which the long

tendons are allowed to pass: it comes off from the heel in one point; it grows broader in the same proportion as the sole of the foot grows broad. It is divided into three narrow heads, which make forks, and are inserted into the roots of the second, third, and fourth toes; and the great toe and the little toe have two smaller or lateral aponeurosis, which cover their own particular muscles, and are implanted into the roots of the great toe and of the little toe.

The *bursæ mucosæ* surround the ankle and foot in great numbers. None of them having any very direct connexion with the joint, and most of them accompanying the long tendons as they pass behind the ankle, or in the sole of the foot, are of that kind which we call tendinous sheaths. First, there are sheaths of two or three inches long, which surround the tendons of the *tibialis posticus*, and of the *peronæi* muscles, as they pass down behind the ankle. the sheath of the *peronæi* begin from that point where the tendons first begin to rub against the bone, and are continued quite down into the sole of the foot; making first a common sheath for both tendons, and then a bursa peculiar to the tendons of the *peronæus brevis* muscle, and about an inch in length. When the *peronæus longus* begins to pass under the sole of the foot, the sheath which enclosed it behind the ankle is shut, and a new bursa begins; in the same manner where the tendons of the *flexor pollicis*, and *flexor digitorum pedis*, pass behind the inner ankle, a bursa of three inches in length surrounds them, and facilitates the motion. As the tendons of the *flexor* muscles go under the arch of the foot, they lie among soft parts, and rub chiefly against the flesh of the *massa carnea*, and the belly of the short *flexor* muscles: but whenever they touch the first joints of their toes, they once more rub against a hard bone. New *bursæ* are formed for the tendons; each bursa is a distinct bag, running along the flat face of the toe, and is of a long shape, and the tendon is carried through the centre of the lubricated bag, so that we see once more, that there is no true distinction betwixt *bursæ mucosæ* and tendinous sheaths; nor betwixt the tendinous sheaths and the capsules of joints

Joints have been arranged under various forms, but not with much success; and I do not know that enumerating the joints in any particular order will either explain the motions of individual joints, or assist in recording their various forms; some joints are loose and free, capable of easy motions, but weak in proportion, and liable to be displaced; such is the JOINT of the SHOULDER, which rolls in every direction; other rolling joints, more limited in their motions, are better secured

with ligaments of peculiar strength ; such is the JOINT of the HIP, where the ligaments are of great strength both within and without ; some wanting all circular motions, are hinge-joints, by the mere form of their bones ; such are the LOWER JAW, the VERTEBRÆ, the ELBOW, and the ANKLE-JOINTS ; some are hinges by their ligaments, which are then disposed only along the sides of the bones ; such are the KNEE, the RIBS, the FINGERS, and the TOES. Some joints partake of either motion, with all the freedom of a ball and socket-joint, yet with the strength and security of the strictest hinge ; thus the WRIST having one joint by which its turning motions are performed, and another joint by which it rolls, has the two great endowments, so rarely combined in any joint of the freest motion, and of great strength ; so also has the HEAD, by the combination of two joints of opposite uses and forms ; for its own condyles play like a mere hinge upon the atlas, and the axis of the dentatus secures all the properties of a circular joint ; this combination gives it all the motions of either joint, without their peculiar defects. But there is still a third order of joints, which have such an obscure and shuffling motion, that it cannot be observed. The CARPUS and METACARPUS, the TARSUS and METATARSUS, the TIBIA with the FIBULA, have these shuffling and almost immoveable joints ; they are not intended for much motion among themselves, but are appointed by a diffused and gradual yielding, to facilitate the motions of other joints.

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THE
ANATOMY
OF THE
HEART AND ARTERIES.

BOOK I.
OF THE HEART.

CHAP. I.

OF THE MECHANISM OF THE HEART.

THE heart is placed nearly in the centre of the human body, and is itself the centre of the circulating system. The system of vessels which it excites and moves, consists of arteries and of veins ;—the arteries act with great strength, with a pulsation like that of the heart itself, and convey the blood over all the body ; the veins are in greater number, exceedingly large, pellucid almost in their coats, incapable of that energetic action with which all the functions of the arteries are performed ; they return the blood to the heart with a slow, equable, and gentle motion, and deposite at the right side a quantity of blood equal to that which is at each pulsation driven out from the left. The heart is placed betwixt the arteries and the veins, to regulate and enforce their action ; to receive the blood from the veins by a slow dilatation, and to restore, by a sudden contraction, that force, which the blood loses in passing round the circle of the body. but the heart has also another and more important office to perform : for by having four great cavities and two orders of arteries, it performs in the same instant two circulations, one for the lungs and one for the body ; it receives from the lungs nothing but pure blood, it delivers out to the body nothing but what is fit for its uses : and this purifying of the blood, and this excite-

ment of the arteries, are two chief points of modern physiology, which every step of the following demonstration will tend to explain.

It will be most easy to conceive at first the idea of a more simple heart, of one circle of actions, of one simple circulation ; of one bag for receiving, and another joined to it for propelling the blood. Indeed a heart consists merely of these essential parts ; a GREAT VEIN, an AURICLE, a VENTRICLE, and a GREAT ARTERY : of a vein which returns the blood from all the body ; of an auricle or smaller bag, which receives that blood and retains it till the action of the heart is relaxed : of a ventricle (which is the proper heart) strong, muscular, very irritable, and easily excited, into which the auricle pours its blood ; of an artery which is allied to the ventricle in strength and action, (as the auricle is to the vein in the delicacy of its coats,) and which carries on the blood to the extremities of the body ;—and the vein and artery meeting at their extremities in the body, and uniting, the whole is a circle, and the heart is the central power.

If an animal do not breathe, its system will be what I have now described : it will have but one vein, one auricle, one ventricle, one artery ; it will have one simple heart : but with us, and other breathing animals, it is not so ; and I am now to describe a more complex and curious circulation. For suppose this blood, so essential to our existence, to have in it some principles of life, which is continually lost, or in its passage through the body, to be impregnated with something which should be thrown off, that principle must be continually renewed, or an opportunity given to send off what is offensive to life : the heart which fills the arterial system, must not be taken from its appointed office, nor disturbed ; nature appoints a second heart, which belongs entirely to this most important of all functions, viz. renewing the blood ; and it may be renewed in many various ways. It might, for example, circulate in some peculiar viscus, like the liver or spleen ; in the fœtus it does circulate in such a mass, for the placenta is a thick and flat cake, whose office we know to be equivalent to that of the lungs, but whose structure we do not understand : in the chick we see its blood circulating over the yolk, (for the yolk is enclosed within the membranes of the unhatched chick,) and we perceive the blood redder as it returns to the heart, and plainly changed ; in fish we find the blood circulated over the gills, exposed thoroughly to the water in which they swim, and thus the gills perform to them the function of lungs. But in all breathing creatures, the lungs do this office ; the lungs are, next to the heart itself, essential to life : in those

who die from bleeding, we can perceive from the livor of the face, from the sobbing and struggles of the chest, from the regular convulsive sighs of those creatures which are butchered, rather a desire for air than a want of blood. It is for the purpose of this second circulation that nature has appointed in all the warm blooded animals two hearts, a heart for the lungs, and a heart for the body; two veins, two auricles, two ventricles, and two great arteries, one the pulmonic artery, or artery of the lungs, the other the aorta, or artery of the body.

There are other varieties which distinguish animals into creatures of cold or of warm blood; for there are certain constitutions which do not require that the blood should be thus continually renewed. It is not because animals are amphibious, or go into the water, that they have peculiar lungs; for the Land Tortoise, the Newt, the Cameleon never go into the water; yet they have membranous lungs: nor indeed can the amphibizæ, as the Seal, the Porpoise, the Sea-Lion, &c. dive and exist under water more than a man can do, though for whole days they lie in herds basking upon the shore: it is their peculiar constitution to need less than other creatures the office of the lungs. The cold-blooded animals are generally creeping animals, sluggish, languid, cold, inert, difficultly moved, and tenacious of life to a wonderful degree. They can bear all kinds of stimuli; they can bear to have their heads, legs, bowels, cut away; and among other peculiarities of this constitution, they can live long without air: they will rise from time to time above water, if you allow them; they can bear again to be kept under water, if you force them: but if they can live long under water, they can also live at least as long after you have cut off their heads, or cut out their hearts.

Of those cold-blooded creatures always either the heart or the arteries are peculiar; the heart is so in many amphibizæ, as in the Turtle, where the heart seems to consist of three ventricles, but with partitions so imperfect betwixt them that they are absolutely as one: this one ventricle gives out both the great arteries; the blood of the lungs and the blood of the body are both mixed in the heart: and since there are two arteries conveying this mixed blood, if the two arteries be nearly equal in size, then it is just one half of the blood thrown out by the heart at each stroke that receives the benefit of the lungs. In many others, as the frog, the newt, the toad, the peculiarity is in the arteries alone; they have one single and beautiful heart; there is one large auricle as a reservoir for all the blood both of the body and of the lungs; there is one neat, small and very powerful ventricle placed

below the reservoir, having strength quite sufficient for moving both the blood of the lungs and the blood of the body ; and this ventricle gives off an aorta, which soon divides into two branches, one for the body, and one for the lungs ; and these of course have but half the blood of this heart exposed to the air : these also are cold-blooded animals.

But all breathing creatures, such as are called animals of hot blood, have two hearts : the one heart is sending blood through the lungs, while the other heart is pushing its blood over the body ; not the half only, but the whole blood which is sent by each stroke of the heart over the body must have first passed through the lungs ; no blood can reach the heart of the body which has not been sent to it through the lungs ; or, in other words, the veins of the lungs, and they alone, feed the left side of the heart.

Words alone will never explain any of the endless difficulties which concern the mechanism of the heart ; but at every point, in every kind of difficulty, in explaining the form, the parts, the posture, even the coats or coverings of the heart, I shall have recourse to plans, such as cannot fail to make all this intricate mechanism be easily conceived.

The most simple form of the heart, which is represented in the plan, No. 1. has a vein marked (*a*)—and auricle (*b*)—a ventricle (*c*)—an artery (*d*)—it has no provision for purifying the blood ; it has no resemblance to that kind of heart which is connected with lungs ; but the blood is received by the vein, falls into the auricle, is driven by its force into the ventricle, by the ventricle it is thrown into the artery, and courses round all the body, till at length, reaching the extremities of the veins, it passes by the veins to the auricle a second time, and so this single circle is perfect.

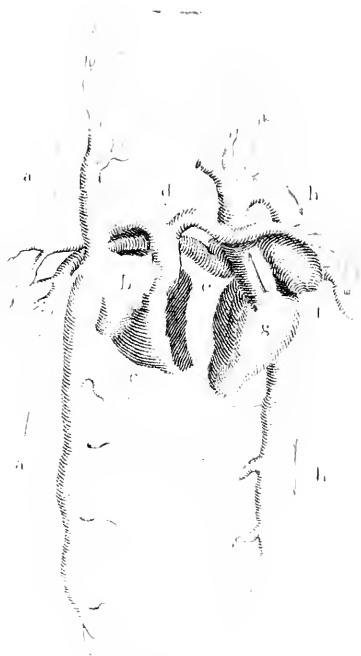
The heart of the amphibious creature is represented in No. 2 ; it is a frog's heart : it has the most simple form, and the fewest parts ; it has the same vein, auricle, ventricle, and artery ; but its great artery divides into two chief branches, of which (*d*)—the aorta goes to the body,—(*e*) the pulmonic artery goes to each side of the lungs.

The heart of a breathing creature is represented in No. 3. in its most intelligible form ; and the double circulation of the human body may be traced easily in the following way.—Here the heart of the lungs is set off from the heart of the body, being as distinct in office as in form and parts ; on the right side is the heart of the lungs, on the left side is the heart of the body.—(*a*) Is the great vein called vena cava from its immense size ;—there is an ascending and a descending cava ; the one brings the blood from the head and arms, the other

N^o 1



N^o 3



N^o 2



N^o 4





brings the blood from all the lower parts of the body ; they meet at (b) and form by their dilatation there, a chief part of that bag which is called the auricle,—in it they deposite all the returning blood of the body, and thus present it at the right side of the heart to be moved through the lungs.—(b) Is the right sinus, or RIGHT AURICLE ; it is in part formed by a dilatation of these veins, but it puts on a strong and muscular nature as it approaches the heart ; it is the first cavity of the heart, and, like all its parts, is strong and irritable : it is filled by the returning blood of the cavæ ; it receives, dilates, is oppressed by this great quantity of blood ; it is strongly excited to act ; in its action the blood goes down into the ventricle or lower cavity of the heart.—(c) Is the RIGHT VENTRICLE, thick and strong in its walls, and of great muscular power : it is filled by the auricle, and is strongly stimulated both by the stroke of the auricle, and by the weight and quantity, and also, in some degree, by the qualities of the blood ; its action is sudden and violent, and it drives the blood through all the system of the lungs.—(d) Is the PULMONIC ARTERY,—the artery of the lungs, which receives all the blood of the right side of the heart ; it is filled by the stroke of the right ventricle, from whose cavity it arises ; it carries the blood in many branches through all the substance of the lungs ; and thus that blood which had returned imperfect and robbed of its vital quality to the right auricle of the heart, is by this circulation through the pulmonic artery ventilated and renewed, and made fit for the uses of the system ; and thus the lesser circulation, or the circulation of the lungs, the circulation of the right side of the heart is completed, and the purified blood is brought round to the left side of the heart to undergo the greater circulation or the circulation of the body.

Thus it is from the extremities of this first circle that the second circle begins ; it consists of like moving powers, of an auricle, ventricle, vein, and artery ; for as the right heart receives the contaminated blood of the body from the veins of the body, the left heart receives the purified blood of the lungs from the veins of the lungs.—(e) Represents the VEINS OF THE LUNGS, which are sometimes three, sometimes four in number ; two enter from each side of the lungs, and return the blood purified in the lungs to the left auricle of the heart.—(f) Is the LEFT AURICLE, smaller, but more muscular, and stronger than the right ; it receives easily whatever quantity of blood the lungs convey to it ; it is irritated, contracts, forces the mouth of the ventricle, and fills it with this purified and redder blood.—(g) Is the LEFT VENTRICLE, whose form is longer, its fleshy walls thicker, its cavity smaller, its power greater far

than that of the right side ; this ventricle is thus small that it may be easily filled and stimulated, and thus strong that it may propel all the blood of the body.—(h) Is the AORTA or great artery of the body, arising from this left ventricle, just as the pulmonic artery arises from the right : the left ventricle, by its strong and sudden stroke, not only delivers itself of its own blood, but propels all the blood of the body, communicates its vibratory stroke to the extremest vessels, and excites the whole ; this is the greater circle or circulation of the body, as opposed to the shorter circulation or lesser circle of the lungs.

That there are strictly two hearts, is now clearly made out ; they are different in office ; there are two distinct hearts, two systems of vessels, two kinds of blood, and two circulations. These two hearts might have done their offices, though placed in the opposite sides of the breast ; it is in order to strengthen naturally the effect of each other that they are joined ; for the fibres of the two hearts intermix ; they are both enclosed in one membranous capsule, viz. the pericardium ; the veins, auricles, ventricles, and arteries, correspond in time and action with each other, and harmonize in a very beautiful manner. But this, I believe, will be more easily explained by marking the succession of motions, by a suite of figures placed upon the several parts of the heart, by which the successive motions are performed.

In No. 4. I have joined the right and left hearts ; both that it may be seen how the left heart locks in behind the right heart, how the right heart comes to be the anterior one, and how the aorta seems to arise from the centre of the heart while its root is covered by the great artery of the lungs ; and also that the synchronous parts, (*i. e.*) the parts which beat time with each other may be correctly seen.—1. The CAVAS are receiving the blood from all parts of the body, and in the same instant the pulmonic veins are receiving blood from the lungs. 2. The RIGHT AURICLE is gradually filling with the contaminated blood of the body ; the left auricle, marked also with a second figure, is filling with purified blood from the lungs. 3. The RIGHT VENTRICLE is stimulated by its auricle, and throws its contaminated blood into the lungs ; and in the same moment the left ventricle throws its purified blood over the body. 4. The PULMONIC ARTERY re-acts upon the blood driven into it by the heart ; and in the same moment the aorta re-acts upon the blood thrown into it, and that re-action works it through all this great system of vessels from this the centre to all the extremities of the body.





Thus it is easy to perceive how the successive actions accompany each other in the opposite sides of the heart: 1. The two veins swell; 2. The two auricles are excited: 3. The two ventricles are filled with blood; 4. The two arteries take up and continue this pulsating action of the heart. It is thus that the two hearts assist and support the actions of each other, and there seems almost a physical necessity for their being joined; yet on the very best authority, and after deliberate dissection, we are entitled to affirm, that the heart is found, not with its apex sharp and conical, but cleft; the two ventricles plainly distinct from each other, and divided by a great space. "*Latro, quæ pœnas scelerum luebat, quando exenteraretur a carnifice, cor habuit singularis figuræ, mucrone non acuto, ut fieri solet, sed bifido; ut distincti ventriculi manifestius externa fascie apparuerint, dexter nempe et sinister, interjecto magno hiatu.*"*

OF THE PARTS OF THE HEART.

As yet I have explained only the general plan of the circulation, without having described those curious parts which are within the cavities of the heart, and which support the actions in this beautiful harmony and perfect order, each part subordinate to some other part, and each action succeeding some other action with perfect correctness, often without one unsteady motion or alarming pause, during the course of a long irregular life.

1. The *VENÆ CAVÆ* are two in number;† they are named *venæ cavæ* from their very great size; the one brings the blood from the upper, and the other from the lower parts of the body, and they are formed of these branches: the upper *vena cava* (*a*) is properly termed the *DESCENDING CAVA*, because it carries the blood of the head and arms downwards to the heart: this great vein is properly a continuation of the right jugular vein, which joins with the right axillary vein, and then descends into the chest a great trunk; and in the upper part of the chest it is joined at (*b*)—by a great branch, containing the axillary and jugular veins of the left side, which, in order to reach the cava, crosses the upper part of the chest, and lies over the carotid arteries. The lower *VENA CAVA*, or

* Bartholini Epist. p. 170. There are examples in the lower animals, of the hearts being actually in distinct parts of the System.

† Let the reader observe, that the whole of this description of the various parts of the heart is, as it were, an explanation of the plans No. 5 and 6; of which the No. 5 shows the right side of the heart, or the heart of the lungs opened; while No. 6 shows only the left heart, or the heart of the body opened.

CAVA ASCENDENS, brings in like manner all the blood from the belly and lower parts of the body by two great branches. One, marked (*c*,)—is the great vein which lies in the belly along the right side of the spine, and brings the blood from the legs, the pelvis, and parts of generation, the kidneys, &c.; it is named the VENA CAVA ABDOMINALIS, because of its lying in the abdomen. Another, marked (*ddl*,)—arises in three or four great branches from the liver; it is named the branches of the vena cava of the liver, or the VENA CAVA HEPATICA; and these two make up the lower cava; and the lower and the upper cava now join themselves at (*e*,)—to form the right sinus of the heart.

2. The RIGHT SINUS OF THE HEART, marked (*e*,) is of considerable extent; it is just the gradual dilatation of the two veins forming the auricle or reservoir which is incessantly to supply the heart; the veins grow stronger as they approach the sinus, and the sinus still stronger as it approaches the AURICLE or notched and pendulous part (*f*,) and the auricle again approaches in its nature to the ventricle of the heart; for it is crossed with very strong muscular fibres, which make very deep risings and furrows upon the inner part. To say that these veins, or the sinus which they form, are not muscular, merely because they are not red nor fleshy, is very ignorant; for the ureters, arteries, intestines, the iris, and many other parts of the human body, are at the same time, perfectly muscular and perfectly pale; and the heart of a fish is as transparent as a bubble of water, and yet is so irritable that after it is brought from market, if you lay open the breast, and stimulate the heart with any sharp point, it will renew its contractions, and in some degree the circulation.

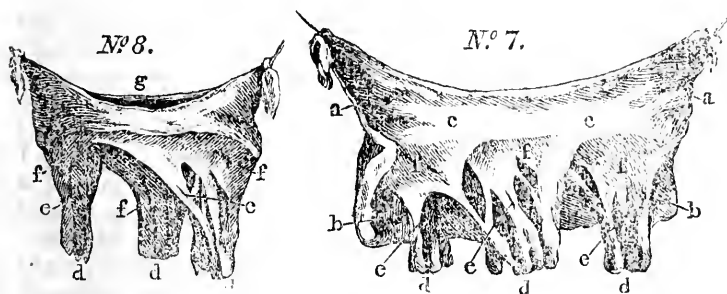
3. The TUBERCULUM LOWERI should be looked for in this point, if it were not really an imagination merely of that celebrated anatomist. The whole matter is this; the two veins meet, not directly, but at a considerable angle within the vein, as at (*g*,) Lower conceived a projection of the inner coats of the vein at this point much more considerable than what I have here represented. It was thought to do the office of a valve, to break the force of the descending blood, to defend from pressure that blood which is ascending from the lower cava, and to direct the blood of the upper cava into the right auricle of the heart. But there is no such thing; although anatomists were at one time so fond of this trivial observation that not one of them would demonstrate the heart, without demonstrating the tuberculum Loweri: whereas, if the blood of the lower cava needs any screen above it to defend it from the pressure, it is (as I shall show presently) quite of another kind; and in the place appointed for finding this tuberculum

Loweri we can find nothing but on the inside or the natural angle of the two veins, and on the outside some fat cushioned up in that angle in the line (*k*.) Though generally wanting, I have found the tuberculum Loweri very distinct in the human heart.

4. The AURICLE is, as I have said a small appendix to the great bag or sinus, and is marked (*f*.) It is small, semi-circular, notched or scolloped, and somewhat like a dogs ear; whence its name. In general, we name the whole of this bag auricle; but by this plan the names of sinus and auricle must be easily understood. The point chiefly to be noted is this, that the veins, as they approach the auricle, are thin, delicate transparent; that where they expand into the sinus they become fleshy, thick and strong; that in the auricle itself the muscular fibres at (*f*) are very strong, have deep sulci like those of the ventricle, cross each other so as to make a network; and these strong fibres(*f*) are what are named the *musculi pectinati auriculæ*. Where these muscles run, as in cords, across the auricle, they are very thick and opaque; but in the interstice of each stripe or muscular fibre, the auricle is transparent, like the membranes of the veins; and these stripes of muscular fibre which are laid upon this thin membrane are almost as regular as the teeth of a comb; and thus they are named *MUSCULI PECTINATI*.

5. The VALVES of the AURICLE are placed at the circle (*i*), where the auricle enters into the ventricle, and the valves are marked (*k*), and how necessary these are for regulating the

AURICULAR VALVES.



AURICULAR VALVES explained.

Fig. 7. shows the Auricle and Ventricle cut open, and the valve hanging in three great divisions —(*a*) Part of the inside of the Auricle.—(*b*) Part of the inside of the Ventricle.—(*c*) The tendinous Circle from which the membrane of the valve arises.—(*d*) The Columnæ Carnæ.—(*e*) The Cordæ Tendinæ.—(*fff*) The three great divisions of the Valve—No. 8 shows the circle of the entrance of the Auricle still entire; where—(*g*)—marks the entrance into the Auricle.—(*fff*) The three divisions of the Valve.—(*d*) the Columnæ Carnæ;—and (*e*) The Cordæ Tendinæ.

movements of the heart will be easily understood by considering the conditions in which the auricle and ventricle act. First the cavæ pour in a flood of blood upon the sinus and auricle, with a continual pressure; the moment the auricle has contracted it is full again; the pressure from behind excites it to act, and while it is acting there is no occasion for valves to guard those veins whose blood is pressing forwards continually, because they are continually full, and have behind them the whole pressure of the circulating blood. But when the auricle acts, it throws its blood into the ventricle, fills it, and stimulates it; the auricle then lies quiescent for a moment, while it is gradually filling from behind with blood; but during this quiescent state the whole blood from the ventricle would rush back into it, were it not guarded by valves. The valves, then, which rise whenever the ventricle begins to act, are of this kind: there is, first, a tendinous circle or hole, by which the auricle communicates with the ventricle. The opening is large enough to admit two or three fingers to pass through it; it is smooth, seems tendinous, is plainly the place of union betwixt the auricle and ventricle, which are in the fœtus (in the chick, for example,) distinct bags; and from all the circle of this hole arises a membrane, thin, and apparently delicate, but really very strong; not divided into particular valves at this root or basis, but as the membrane hangs down into the ventricle, it grows thinner and is divided into fringes. How these fringes can do the office of valves is next to be explained. The tags and fringes of this membrane are actually tied to the inside of the ventricle by many strings, which being, like the valves, of a tendinous nature, are called *CORDÆ TENDINÆ*, or tendinous cords; and these cords being attached to little processes projecting from the muscular substance of the heart, these processes are named *COLUMNÆ CARNEÆ*, or fleshy columns. Of these tyings of the valves there are three chief points; the whole circle seems to be divided into three sharp-pointed valves; or they are named *VALVULÆ TRICUSPIDES*, or three-pointed, or they are still sometimes called Triglochine Valves. The valves fall down easily when the blood goes down through them, and they rise readily and quickly whenever the blood gets behind them: when the ventricle is full the valves are still open, but when the ventricle contracts, the blood throws up the valves, and closes the opening into the auricle, and now the tendinous cords and fleshy columns support the margins of the valves, so that they give them strength to support the heart's action.

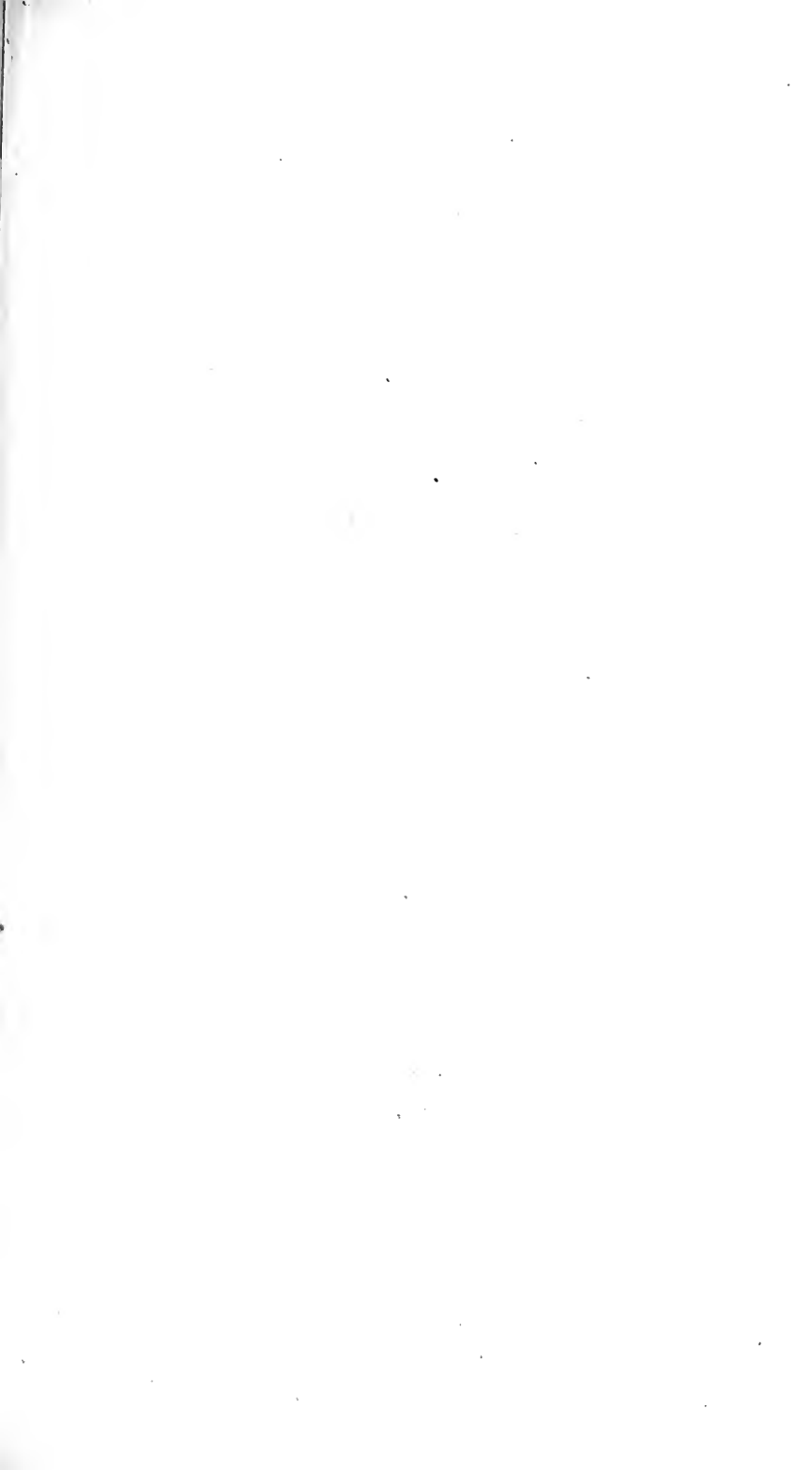
6. The *VENTRICLE* of the *RIGHT SIDE* (*II*) is like its auricle, larger than the same parts on the left side; for this auricle

and ventricle of the right side have the weight of the whole blood of the body pressing upon them. They are subject to occasional fulness, for they must be dilated by many accidents, as labour, violent struggles, &c. which send the blood too quickly upon the heart; while the left auricle and ventricle, on the other hand, can never be over loaded, as long as the pulmonic artery preserves its natural size, for that artery continues always the measure of the quantity of blood which they receive. The ventricle is thick, strong, fleshy. Its inner surface is extremely irregular; it puts out from every part of its surface very strong fleshy columns. These fleshy columns are irregular in size, big, strong, running along the length of the ventricle; some across the ventricle, so as to connect its opposite walls together; some have the tendons of the valves fixed to them; all of them have perfect contractile power, and are indeed the strongest muscles of the heart. Betwixt the fleshy columns, there are, of course, very deep and irregular grooves: and among the confused roots of these fleshy columns the blood often coagulates after death, seldom before it, into the form of what are called polypi of the heart. Yet still the walls of the right ventricle (*ll*)—are thinner, the fleshy columns smaller, the cavity greater, than those of the left side; the right ventricle of the heart has also a peculiar form for the SEPTUM CORDIS, a partition betwixt the right and left heart, is not, as generally supposed, a part common to both; but the left ventricle is much longer and more conical than the right one; the septum belongs almost entirely to the left ventricle; the right ventricle which is much bigger, laxer, flatter, and thinner in the walls, is, as it were, wrapped round the left; and thus the left ventricle alone forms the acute apex of the heart, and the left ventricle of necessity bulges very much into the cavity of the right, since the right ventricle is so much larger, and in a manner wrapped round it. ‘In both ventricles, it is very remarkable, that towards the opening of the auricle the surface of the ventricle is very rugged, irregular, and crossed with columnæ carneæ while a smooth and even lubricated channel marked (*m*) leads towards the artery.

7. The PULMONIC ARTERY arises from the right ventricle, to carry out the blood close by the great opening at which the the auricle pours it in; the artery rises at its root in a very bulging triangular shape. It is the valve within the mouth of the artery that gives it this very peculiar shape without; for the bulging root is divided into three knobs, indicating the places of three valves, the artery dilating behind each valve into a little bag, which, when it is described, is called its sinus.

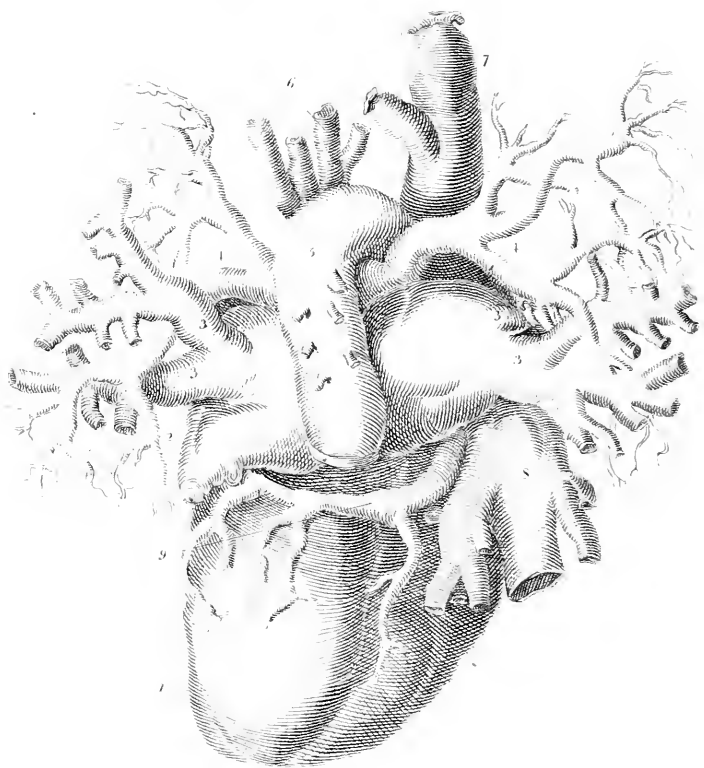
8. This VALVE of the PULMONIC ARTERY (*n*)—has a more perfect and simple form than that of the auricle. The valves in the mouth of each of the great arteries are three in number; they are thin but strong membranes, rising from the circle of the artery, where it comes off from the heart: each valve is semilunar: its larger and looser edge hangs free into the cavity of the artery; the edge is a little thicker than the rest of the valve; the three valves together form one perfect circle, which closes the mouth of the artery so that no grosser fluid, nor hardly air, can pass. When they are filled till they become very tense, each valve forms a kind of bag; so that when you look at the mouth of a dried artery, they appear like neat round bags; and when they are likely to be forced, the little horns or tags; by which each valve is fixed into the coats of its artery, becomes so tense as to do the office of a ligament: these are called the SEMILUNAR or SIGMOID VALVES.

Now the condition of the ventricle while it is contracting is well understood: the auricle by its action lays down the tricuspid or auricular valve, and fills the ventricle; the ventricle cannot feel the stimulus of fulness till its valves rise, and its cordæ tendineæ begin to pull; and the ventricle could not be close for acting, nor its walls perfect, it could not in short be an entire cavity, till the tricuspid or auricular valves were completely raised. But there is another opening of the ventricle, viz. that into the artery, which must be also shut; this is one of the several instances of the subordination of these actions one to another; for, first, the auricle acts, then the ventricle, then the artery: so that the auricle and the artery are acting in the same moment of time; the artery by acting throws down its valve, and closes that opening of the ventricle, while the auricle is filling it with blood; and again, the moment that the ventricle is filled, both the auricle and artery are in a state of relaxation, the auricle valve rises so as to close the ventricle on that side; and the arterial valve falls down, both because the artery has ceased acting, and because the valve is laid flat by the whole blood of the ventricle rushing through it. Hence it is very obvious, that the right ventricle could neither be filled nor stimulated, unless the opening toward the artery were close during the time of its filling; and again, it is obvious that this valve cannot be laid down by any other power than that of the artery itself; who then can doubt that the artery has in itself (like the ventricle) a strong contractile power? That it is the stroke of the artery succeeding that of the heart that lays down this valve so closely, is proved by this, that in many animals, in fishes,



Representing the Back part of the Heart — The great Cerebrary Vein — The Shape of the Atricle — and the entrance of the Pulmonary Veins

N^o 9



for example, the aorta is as plainly muscular as the heart itself, it is like a second heart; and in fishes the vessel returning from the gills, and often in human monsters, the artery alone, by its own muscular power, moves the whole circulation without any communication with the heart. In fishes there is no second heart for the circulation of the body; and in monsters the heart is sometimes wanting, and there is found nothing but a strong aorta to supply its place. This stroke of the pulmonic artery, then (which the heart excites,) pushes the blood through the lesser circle or circulation of the lungs, and by the pulmonic veins it is poured into the left side of the heart.

9. The LEFT AURICLE of the heart is unlike the right auricle in these respects: the sinus, or that part which consists of the dilatation of the pulmonic veins, is smaller, while the auricula, which is the more muscular part, is larger, the pulmonic veins come in four great trunks from the lungs, two from the right side and two from the left; two great veins then enter at each side of the left auricle, by which it gets a more square form; the whole of the left sinus, which forms the chief bulk of this part, is turned directly backwards towards the spine, and is not to be seen in any common view of the heart; but I have here added a plan of the back part of the heart,* showing, 1. How the left ventricle lies behind; 2. How the left auricle is turned still more directly backwards; 3. How the pulmonic veins enter into it in four great branches, so as to give a square or box-like form, compared with the gliding, gentle shape of the right auricle; 4. How the pulmonic artery comes out from under the arch of the aorta, dividing into its two great branches for each side of the lungs; and, 5. How the aorta arches over it, towers above all the other vessels, and is known always among the vessels of the heart by the carotid and subclavian arteries which come off from its arch. On the plan, No. 6 are seen—(oo) the two pulmonic veins entering from each side of the lungs—(pp) the opening of these into the auricle—(qq) the sinus formed in part by the dilatation of these veins, and—(r) the auricula or little ear, from which the whole bag is named auricle.

10. The valves which guard the left auricle are seen here† (ss:)—Now it is to be remembered that the left auricle is

* Explanation of the BACK VIEW of the HEART, 9. No. of Plate 7.

1. The left Ventricle—2, The left Auricle—3 3 3 3, The four Pulmonic Veins—4 4, The two great branches of the Pulmonic Artery—5, The Aorta—6, The Carotids and Subclavians—7, The Cava Descendens—8, The Cava Ascendens, with all its branches from the Liver—9, The great Coronary Vein running along the back of the Heart betwixt the Auricle and Ventricle in a groove surrounded by fat.

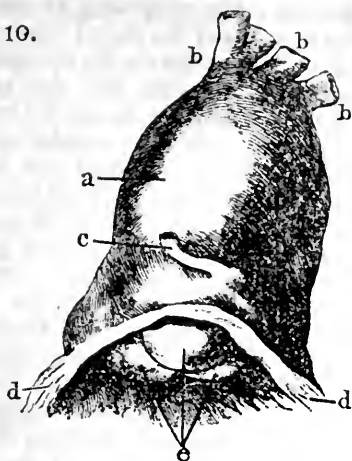
† This begins the description of the left side of the heart, and the description follows the plan. No. 6.

smaller than the right, that the circle or opening of the left auricle is of course smaller than that of the right; that while it requires a valve divided into three points to fill the opening of the right auricle, a valve divided only into two points suffices for the opening of the left auricle; this is the reason of this slight variety of shape betwixt the two auricular valves, and is also the reason of the valve of the right side being called *TRICUSPID* or three-pointed, while this of the left side, from some very slight resemblance to a mitre, is named *VALVULA MITRALIS*, the *MITRAL VALVE*. In all other points this valve is the same with that of the right side, it has the same apparent thinness, for it is even transparent, the same real strength, the same *COLUMNÆ CARNEÆ* and tendinous strings to support it; the same rough irregular surface towards the opening of the auricle; the same smooth gutter leading towards the artery. The constitution of all these parts, in short, is expressly the same: so that even concerning the left ventricle there is nothing further to be observed, but that while it is much longer than the right ventricle, it is much smaller in its whole cavity, is much stronger in its *COLUMNÆ CARNEÆ*, and much thicker in its fleshy walls, as at (*tt*) where it is seen to be thicker than the right ventricle, it is indeed nearly three times as thick.

11. The *SEMILUNAR VALVES* of the aorta are also seen in this general plan at (*u*)—where manifestly the general structure, and general intention of the valves are the same as in those of the pulmonic artery; but still we find at every point marks of superior strength and more violent action in the left side of the heart; for though this valve be expressly like that of the pulmonic artery, and named like it semilunar, yet it is thicker and stronger in its substance, and is peculiarly guarded by three small hard tubercles, which being placed one on the apex or point of each valve, meet together when the valve is close; and give a more perfect resistance to the blood, and prevent the valve being forced open. These are to be seen chiefly in the opposite drawing, and from their being of the size of sesamum seed, they have the name of *CORPORA SESAMOIDEA*; sometimes they are named *Corpuscula Arantii*.

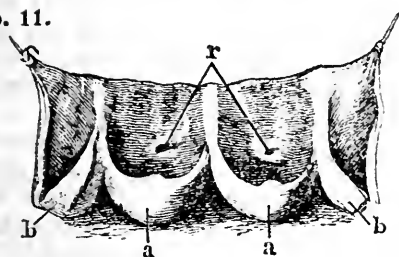
12. The *AORTA* arises from its ventricle very large and strong; it swells still more at its root than the pulmonic artery does; the three subdivisions of this swelling, which mark the places of the semilunar valves, are very remarkable; the curvature at the arch of the aorta is called its great sinus, and these three smaller bags are called the three lesser sinuses of the aorta.

No. 10.



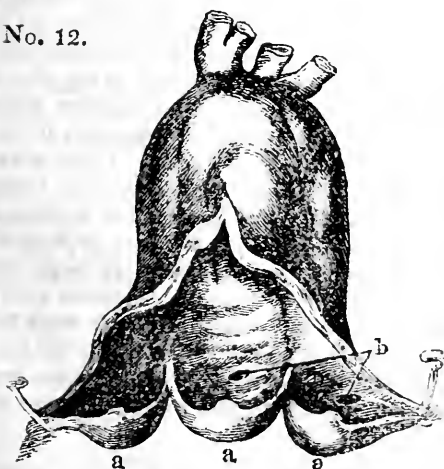
No. 10 shows the aorta entire, but its root within the heart opened so as to show its valve—(a) The body of the aorta; the arch is marked by (bb) the carotids and subclavians—(c) Show one of the coronary arteries or artery of the heart.—(d) A part of the walls of the heart.—(eee) The three valves stuffed and turgid towards the heart.—

No. 11.



No. 11 shows the lower part of the aorta cut open, and two of the valves—(aa) entire; and the third valve—(bb)—cut in two by slitting up the artery.—And (rr) shows the mouths of the two coronary arteries.

No. 12.



No. 12 shows the aorta slit only in its lower part, and the valves (aa) and the mouths of the coronary arteries (bb) are seen in their natural situation.—N. B. In these two last drawings the corpora sesamoidea are distinctly seen in the central part of the edge of each valve, and they need no letter to distinguish them.

OF THE CORONARY VESSELS.

But there still remains to be explained that peculiar circulation by which the heart itself is nourished, and yet there is nothing in it very different from the usual form of arteries and veins; it is a part of the general circulation of the body, for the heart is nourished by the two first branches which the aorta gives off. The circulation destined for the nourishment of the heart is peculiar in this chiefly, that the forms of the arteries and veins of the heart are beautiful, and that the arteries rise just under the valves of the aorta, while the veins end with one great mouth in the right auricle. The coronary arteries are two in number, of the size of crow-quills; we see from the inside of the artery their mouths opening above the sigmoid valves. One artery comes from the lower side of the aorta; it lies towards the right: it belongs chiefly to the right ventricle; it comes out first betwixt the roots of the aorta and pulmonic arteries; it passes in the furrow betwixt the right ventricle and auricle, and turning round arrives at the back part of the heart, and runs down along the middle of that flat surface which lies upon the diaphragm; and when it arrives at the apex of the heart, its extreme arteries turn round the point and inosculate with the opposite coronary. The other coronary belongs in like manner to the left side of the heart, and arises from the upper side of the aorta; it first goes out betwixt the pulmonic artery and the left auricle, and then turning downwards upon the heart, it runs along that groove which is betwixt the ventricles, and marks the place of the partition or septum ventriculorum; its chief branches turn towards the left ventricle, and branch out upon it; it belongs as peculiarly to the left side of the heart as the other does to the right side: after supplying the left ventricle, &c. it turns over the point of the heart to meet the extremity of the first, and inosculate with it. Both these arteries give branches not only to the flesh of the ventricles, but to the auricles, and also to the roots of the great arteries, constituting the *VASA VASORUM*, as such minute branches sent to vessels are called.

The GREAT CORONARY VEIN which collects the blood of these arteries, arises in small branches all over the heart; these meet so as to form a trunk upon the forepart of the heart where the septum or union of the ventricles is. While small, the veins accompany their respective arteries; but after the great trunk is formed, the vein takes its own peculiar route. When the trunk of the great coronary vein (accompanied by several lesser veins) arrives at the auricle, it runs in

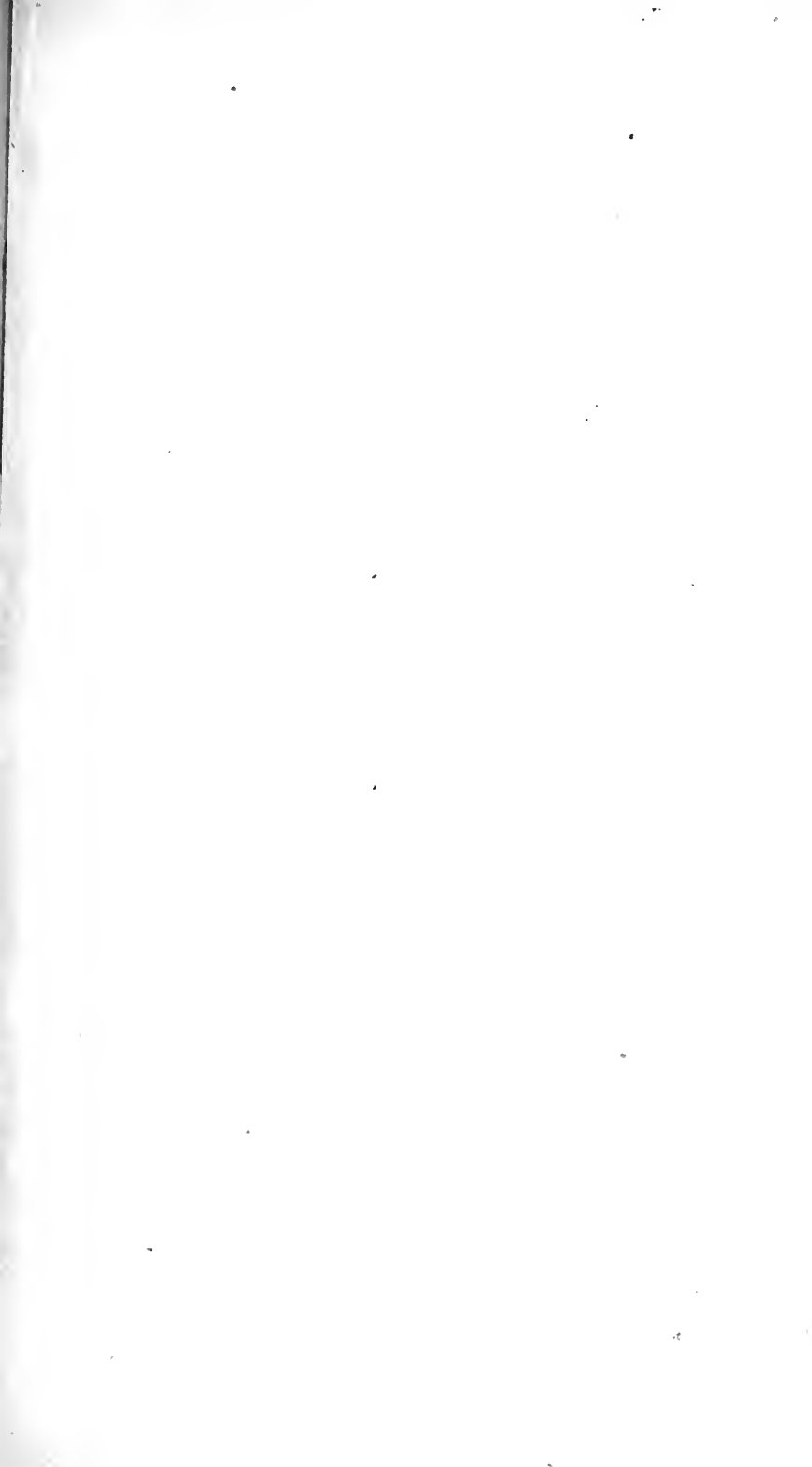
between the left auricle and left ventricle ; it turns all round the back of the auricle till it gets to the right side of the heart ; it lies in the deep groove betwixt the auricle and ventricle, surrounded with much fat ; and having almost entirely encircled the heart, it discharges its blood into the right auricle, close by the entrance of the lower cava. The opening is very large ; it lies just above the tendinous circle of the auricle, and it is guarded with a strong semilunar valve. This is the great coronary vein ; all the veins which appear upon the heart are but branches of it ; what are called the MIDDLE vein of the heart, the vein of the right auricle, the vena innominata, &c. are all but branches of the great coronary vein running along the right side or lower surface of the heart ; if there were to be any marked distinction, it should be into the GREAT CORONARY VEIN belonging to the left side of the heart, and the VENA INNOMINATA belonging to the right side. But one thing more is to be observed ; viz. that upon the inner surface of the right auricle may be seen many small oblique and very curious openings, which serve for the mouths of veins, while their obliquity performs the office of a valve. This name of coronary vessels is a very favourite one with anatomists, and is applied wherever vessels surround the parts which they belong to, however little this encircling may be like a crown ; and it is thus we have the coronary arteries of the stomach, coronary arteries of the lips, and coronary arteries of the heart. But these vessels of the heart are really very beautiful, and have some things very peculiar in their circulation : first, with regard to the coronary arteries, they lie with their mouths under the sigmoid valves ; or at least in so equivocal a manner, that their peculiar posture has given rise to violent disputes ; viz. whether they be filled, like all the other arteries, by the stroke of the heart, or whether they be covered by the valve so as to let the blood rush past them during the action of the heart.

We see the opening of the coronary arteries rather, as I imagine, under the valve : though Haller says they are above the valve, and that the highest point to which the margin of the valve reaches in very old men is below the opening of the coronary artery, and half way betwixt it and the bottom of the sinus or little bag behind the valve. But let this be as it will, if the condition of the aorta be considered, it will be found to make no difference ; for though the valves rise and fall, are at one time fully opened, and at another time closely shut, still in both these conditions of the valve the aorta is as full as it can hold ; its contraction instantaneously follows that of the heart, but its contraction is not, like that of the heart, such

as to bring its sides together ; on the contrary, the aorta is full when the heart strikes, the action of the heart distends it to the greatest degree, the aorta re-acts so as to free itself of this distention, but still it remains in some degree full of blood ; else how could this, like every other artery, preserve always its form and apparent size ? In this condition of matters, it is obvious that the coronary branches are on the same footing with all the other branches of the aortic system ; that, like all the other arteries, they first feel the stimulus of fulness from the push of the heart, and along with it the stroke of the aorta.

Secondly, with regard to the coronary veins a dispute has arisen more violent than this ; for it has been doubted whether the coronary veins, large as they are, do actually convey the whole of the blood which the coronary artery gives out. Veussens believed that some of the coronary arteries opened directly into the cavities of the heart, without the interposition of veins. Thebesius, after him, believed that there were some shorter ways by which the blood was returned ; not by a long circle into the right auricle, but directly into the ventricles of the heart. Veussens, Thebesius, and others who belong to their party, pretended to prove this fact by injections : but what doctrine is there which such clumsy anatomy and awkward injections may not be made to prove ? They used mercury, tepid water, and air ; and they forced these, the most penetrating of all injections, till they exuded upon the inner surface of the heart ; but if they had fixed their tubes, not into the coronary artery, but into the aorta, and had proceeded to inspect, not the heart, but all the viscera of the body, they would have found their injections exuding from every surface ; of the plura and lungs ; of the peritoneum, and intestines ; of the brain and dura mater ; of the mouth and tongue ; and universally through the cellular membrane of the whole body ; but if any coarse injection, as tallow or wax, be used, following this natural course, it keeps within the arteries and veins, and if thin and well prepared, finds its way back to the auricle of the heart ; but this injection also is extravasated and is found in the cavities of the heart.

Du Verney was so far engaged in this question, that having an opportunity of dissecting the heart of an elephant, he tied up the coronary arteries and veins, washed and cleaned very thoroughly the cavities of the heart ; and then tried, by squeezing, and all kinds of methods, to make that blood which was tied up in the coronary arteries and veins exude upon the inner surface of the heart, but with no effect.



Drawing of the Eustachian Valve
from the Heart of a Child
about 3 or 4 years old.

N^o 13

a, A part of the Lungs, *bb*, the Pericardium by which the Heart is suspended, *cc*, the Ventricles of the Heart, *dd*, the Aorta encircled by the Pericardium, *eeee* the Subclavian and Carotid Arteries, *g*, the pendulous part of the Right Auricle, *h*, the Cava descendens by which the Heart is in part suspended, *i*, the Cava ascendens with a pencil passed up into the Right Auricle, this pencil is behind the Eustachian Valve, the Eustachian Valve itself is marked *k*, the little Valve of the Coronary Vein which is connected with it is marked *m*.

On the present occasion, a theoretical answer happens to be as satisfactory as the most correct experiments : and it is this, If there really were to be formed (by disease, for example,) those numerous openings which Thebesius and Veusens describe, then the blood flowing all by these shorter and easier passages, none could come to the great coronary vein ; its office would be annihilated ; and itself, contracting gradually, would soon cease to exist.

OF THE EUSTACHIAN VALVE.

There remains to be explained in the mechanism of the heart one point ; and which I have separated from the others ; not because it is the least important, but because it is the most difficult, and, if I may be allowed to say so, not yet thoroughly understood ; I mean the anatomy of the EUSTACHIAN VALVE ; which, if it had been easily described, should have been first described : for it is a valve which lies in the mouth of the lower cava, just where that vein enters the right auricle of the heart. How imperfect a valve this is, how difficult to dissect or explain, may easily be known from this, that Winslow was first incited to look for the valve by some hints in Sylvius : he was soon after fairly directed to it by finding it in the tables of the Eustachius, which were then first found and published by Lancisi, after the author had been dead 150 years ; and yet with all this assistance Winslow sought for it continually in vain, till at last he reflected, that by cutting the heart in its forepart, he must have always in his dissections destroyed any such valve ; by opening the back part of the cava he at last saw the valve, and demonstrated it to the Academy of Sciences in France ; and having just received from Lancisi his edition of the Eustachian Table, so long hidden, and since so outrageously praised, he called it VALVULA EUSTACHIANA, a name which it has retained to this day, and he added RECTICULARIS, to express its lace-like netted appearance at its upper edge. From Winslow's time to this present day, that is, for eighty years, there has been no good drawing, nor even any perfect description of the valve ; and in the confusion of opinions upon the subject, what its use may be no one knows.

The Eustachian valve lies in the mouth of the ascending cava, just where that great vein is joined to the auricle of the heart. It looks as if formed merely by the vein entering at an acute angle, and by the inner edge of the vein, or that which is joined to the auricle, rising high, so as to do the

office of a valve. The very first appearance of the valve, and its place just over the mouth of the cava seems to point out that use which Lancisi has assigned it, viz. to support the blood of the upper cava, and prevent that column of blood which descends from the cava gravitating upon the opposite column which comes from the liver and lower parts of the body; and yet this, most likely, is not its use. The valve somewhat resembles a crescent, or the membrane called hy-men. It occupies just that half of the cava which is nearest the auricle. Its deepest part hangs over the mouth of the cava, and is nearly half an inch in breadth, seldom more, often less, sometimes a mere line. Its two horns extend up along the sides of the auricle; the posterior horn arises from the left of the isthmus, as it is called, or edge of the oval hole; its anterior horn arises from the vena cava, where it joins the auricle. Behind the valve the remains of the foramen ovale may be seen, now shut by its thin membrane, but still very easily distinguished; for its arch-like edges are so thick, strong, and muscular, that they look like two pillars, and thence are called the *COLUMNÆ FORAMINIS OVALIS*: these two pillars were called *ISTHMUS VIEUSSENI*, and by Haller are named *ANNULIS FOSSÆ OVALIS*, while the remains of the hole itself is so deep that it is named the *FOSSA OVALIS*. Before the Eustachian valve lies the great opening into the ventricle; but betwixt that and the valve there is a fossa or hollow, in which lies the opening of the great coronary vein; and the valve which covers the coronary vein is a neat small slip of white and very delicate membrane, the one end of which connects itself with the forepart of the Eustachian valve; so that both valves are moved and made tense at once.

The Eustachian valve is in general thick and fleshy; it is sometimes reticulated or net-like even in the fœtus, but by no means so often as to vindicate Winslow, in adding *reticulare* to the name: it grows reticulated chiefly in the adult. The only beautiful drawing that we have of a reticular Eustachian valve is in Cowper; and that was from a man of eighty years of age. Perhaps in eight or ten hearts you will not find one that is reticulated in the least degree; in old men it is reticulated, just as all other valves of the heart are, not by any thing peculiar to the constitution of this valve; not by the pressure of the blood and continual force of the vessels, as Haller represents; but by the gradual absorption which goes on in old age, and which spares not the very bones, for even they grow thin and in many places transparent.

This is the simple description of a valve, which has been the occasion of more controversy than the circulation of the

fœtus and the use of the oval hole. Winslow first began about eighty years ago to observe the connexions and uses of this valve; he laid it down as an absolute fact that this valve was almost peculiar to the fœtus; that it was perfect only while the foramen ovale was open; that it vanished gradually as the foramen ovale closed; that in the adult it was seldom seen unless the foramen ovale was also open by chance. It is incredible what numbers of anatomists followed this opinion; for the difficulty of dissecting the valve made it always easier to say that it was only in the fœtus that it could be found: it is also incredible what absurd consequences arose from this doctrine, which, after all, is but a dream, for in fact the valve is more easily shown in the adult heart.*

The foundation being now laid for connecting this valve with the peculiar circulation of the fœtus, they conceived the following theory, which has come down to this very day; viz. that in the child, the great object of nature in arranging its vessels, was to convey the blood which came fresh from the mother's system directly into the carotids, and so plump into the head at once. The pure blood from the mother comes through the liver by the ductus venosus; it is deposited in the lower cava at the right side of the heart; and these anatomists supposed that this current of fresh blood was directed by the Eustachian valve into the oval hole, through that into the left auricle and ventricle, and from these directly into the aorta and carotids; while the foul blood of the upper cava went down into the right auricle and ventricle, and from that into the ductus arteriosus, and so away down to the lower and less noble parts of the body, and to the umbilical arteries, and so out of the system; for the ductus arteriosus, which comes from the right ventricle in the fœtus, joins the aorta only as it goes down the back, and none of its blood can pass upwards into the head.

This is the peurile theory, which modified in various ways, has amused the French Academy, or rather been the cause of a perpetual civil war in it, for a hundred years. This doctrine began with Winslow, it is still acknowledged by Sabbatier; and Haller, after announcing a theory not at all differing from

* One author, I find in the *Acta Vindobonensia*, is exceedingly angry indeed with all the great anatomists, for not connecting more strictly with each other, the anatomy and accidents of the foramen ovale, and Eustachian valve; with Morgagni, Albinus, and Wiedbriecht, he is offended for saying that they had seen the foramen ovale open, without saying one word concerning the state of this valve; and with Lieutaud Portal, and others again, he is equally offended that they should have had opportunities of seeing the Eustachian valve entire without inquiring into the condition of the oval hole. The reason of all this is very plain; the oval hole had not been open, neither in the one situation nor in the other, else it is very unlikely that such correct and anxious anatomists should have described that valve which arises from one of the borders of the oval hole, without observing it open, if it was so; especially as the oval hole, being open, is by no means an unusual occurrence.

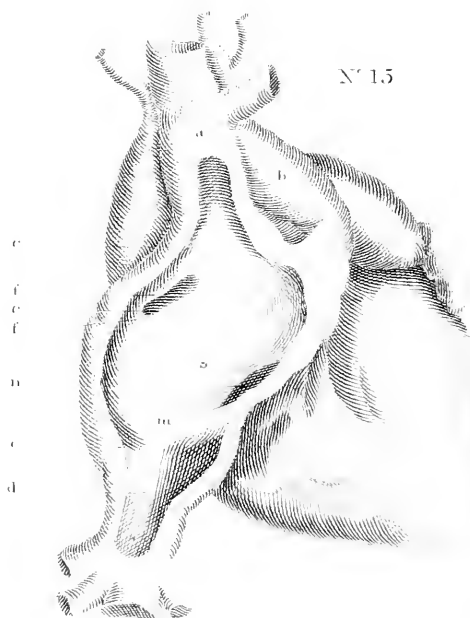
this, challenges it as his own theory ; “ *hanc meam conjecturam etiam a Nichols videtur proponi.*” Of the truth of this theory Haller was so entirely satisfied, that he not only published it as peculiarly his own, but reclaimed it when he thought it in danger of being thus appropriated by another. Sabbatier is the last in the train of authors ; and in order that there might remain no ambiguity in what they had said or meant, he pronounces plainly that the Eustachian valve is useful only in the fœtus, and that there are two opposite currents in the right auricle of the heart ; that the one goes from the lower cava upwards to the foramen ovale, while the other from the upper cava descends right into the opening of the ventricle. What shall we say to anatomists, who, in the narrow circle of the auricle, conceive two currents to cross each other directly, and to keep as clear of each other as the arrows by which such currents are usually represented. This error in reasoning is below all criticism ; it carries us backwards a hundred years in anatomy and in physics ; and yet this is all that Winslow, Haller, Sabbatier, and a mob of others, have been able to say in proof of the connexion of the Eustachian valve with the circulation of the fœtus.

Lancisi, again, believed that it was chiefly useful by supporting the blood of the lower cava, defending it from the weight of that column of blood which is continually descending from above ; and Winslow and others approved of this, as being perhaps one use of the valve. But they have all of them forgotten a little circumstance, which must affect the office of the valve, and which should have been regarded especially by those who said it was useful chiefly before birth ; they have forgotten a little circumstance, which John Hunter also forgot, when theorizing about the gubernaculum testis, viz. that the child lies with its head downmost for nine months in the mother’s womb.

Nothing is more certain than that the Eustachian valve is not peculiar to the fœtus ; that it has no connexion with the oval hole ; that the valve is often particularly large after the foramen ovale is closed ; that the valve is often obliterated where yet the foramen ovale remains open ; that in adults it is more easily demonstrated than in children ; that in old age it is often reticulated as the other valves are. Its use relates neither to the foramen ovale, nor to the ascending cava ; it relates to the auricle itself, and therefore it is found in all the stages of life, smaller or larger, according to the size or form of the heart.

The auricle on the side towards the *venæ cavæ* is imperfect ; the anterior part of the auricle chiefly is muscular, and when it contracts, the laxity of the *cavæ* and the great width of the *SINUS*

Plans of the Custodian Palace



VENOSUS, (*i. e.*) of almost the whole auricle, would take away from its contraction all effect; but to prevent this, and to make the auricle perfect, the vena cava and auricle meet so obliquely, that the side of the cava makes a sort of wall for the auricle on that side. This wall has entirely and distinctly the reticulated structure of the auricle itself, with fleshy bands of muscular fibres in it; this wall falls loosely backwards when the auricle is quite relaxed, as, for example, when we lay it open and thus it has got the appearance and name without the uses of a valve; but when the heart is entire, tense, and filled with blood, this valve represents truly a part of the side of the auricle: and that this part of the wall of the auricle should be occasionally a little higher or lower, looser or tenser, we need not be surprised. This further may be observed, that wherever, as in a child, this valve is very thin and delicate, the anterior part of the fossa ovalis goes round that side of the auricle particularly deep and strong. Let it also be remembered, that in certain animals this valve is particularly large and strong; now, in a creature which goes chiefly in a horizontal posture, it may strengthen and make up the walls of the auricle, (the chief use which I have assigned for it in man;) but surely it cannot protect the blood of the lower cava from the weight of blood coming from above, since the body of an animal lies horizontally, and there is no such weight. The Parisian academicians describe the heart of the Castor in the following terms: "Under the vena coronaria we find the valve called nobilis (*viz.* the Eustachian valve,) which fills the whole trunk of the vena cava, and which is so disposed that the blood may be easily carried from the liver to the heart by the vena cava, but which is hindered from descending from the heart towards the liver through the same vein."*

* EUSTACHIAN VALVE.

No. 14. explains merely the place of the Eustachian valve, which is seen at (*m*)—No. 15. explains both the place of the valve and its relation to the oval hole (*e*)—behind it, the mouth of the ventricle (*n*)—which lies before it.

In both these plans—(*a*) Is the cava descendens—(*b*) The aorta rising behind it—(*cc*) The back of the auricle slit open—(*d*) The cava ascendens, in the mouth of which the valve is—(*e*) The foramen ovale (*ff*) Its two rising borders, named pillars, isthmus of Vieussens, annulus ovalis, &c.—(*m*) The Eustachian valve, of which the two cornua, or sharp points are seen on the lower plate, terminating in the pillars of the foramen ovale on one hand, and in the walls of the auricle on the other. The opening of the foramen ovale (*e*)—is behind and above the valve; the opening into the right ventricle (*n*)—is before and under the valve.

No. 14. explains more particularly the uses of the valve. Some authors conceived that it directed the blood rising in the line (*o*)—upwards into the oval hole: others that it directed the column of blood, represented by the arrow (*p*)—into the right ventricle; others that it protected the column (*o*)—from the weight of the column (*p*).—I rather suppose that it completes the auricle in the direction of the dotted line (*q*)—and so strengthens its action.

OF THE IRRITABILITY AND ACTION OF THE HEART

But even this curious mechanism of the heart is not more wonderful than its incessant action, which is supported by the continual influx of stimulant blood, and by its high irritability and muscular power ; for though we cannot directly trace the various courses of its muscular fibres, there is not in the human body any part in which the muscular substance is so dense and strong. In the heart there can be no direct or straight fibres ; for let them go off from the basis of the heart in what direction they may, still as they belong to the one or the other ventricle, they must by following the course and shape of that ventricle, form an oblique line. Vesalius has not indeed represented them so, he has drawn straight fibres only ; because in the latter end of his great work he was without human subjects, and betook himself to drawing from beasts.

The fibres of the heart are all oblique, or spiral, some lying almost transverse ; they all arise from a sort of tendinous line which unites the auricle to the ventricle ; they wind spirally down the surface till the fibres of the opposite ventricles meet in the septum and in the apex of the heart. The fibres of each ventricle pass over the convex or upper surface of the heart, then over the apex, and then ascend along the flat side of the heart, which lies upon the diaphragm, till they again reach the basis of the heart. The second layer or stratum of fibres is also oblique ; yet many of the fibres run almost transversely, uniting the oblique fibres ; but when we go down into the thick substance of the heart, we find its fibres all mixed, crossed and reticulated in a most surprising manner ; so that we at once perceive both that it is the strongest muscle in the body, and that the attempt to extricate its fibres is quite absurd.* Their desire of giving more correct and regular descriptions has been the cause why those who have particularly studied this point have been fatigued and disappointed ; the most sensible of them have acknowledged with Vesalius, Albinus, and Haller, that the thing could not be done ; while those, again, who pretended to particular accuracy, and who have drawn the fibres of the heart, have represented to us such extravagant, gross, and preposterous things, as have satisfied us more than their most ingenuous acknowledgments could have done, that they also could accomplish nothing.

* Thickening the walls of the heart by vinegar, strong acids, alum, or boiling the heart, have assisted us in unravelling its structure but very little.

There is no question that irritability is variously bestowed in various creatures, that it is variously appointed in various parts of the body, that this property rises and falls in disease and health ; without hesitation we also may pronounce that the heart is in all creatures the most irritable part ; it is the part first to live and the last to die ; “ *Pulsus et vita pari ambulat passu.*” When we see the *punctum saliens* in the chick, we know that there is life ; and when we open the body of an animal soon after death, still the heart is irritable and contracts.

In the very first days in which the heart appears in the chick, while yet its parts are not distinguished, and the *punctum saliens* is the only name we can give it, the heart, even in this state, feels the slightest change of heat or cold ; it is roused by heat, it languishes when cold, it is excited when heated again. It is stimulated by sharp points or acids, it works under such stimuli with a violent and perturbed motion. In all creatures it survives for a long while the death of the body ; for when the creature has died and the breathing and pulse have long ceased, and the body is cold, when the other muscles of the body are rigid, when the stomach has ceased to feel, when the bowels which preserve their contractile power the longest have ceased to roll, and they also feel stimuli no more, still the heart preserves its irritability ; it preserves it when torn from the body and laid out upon the table ; heat, caustics, sharp points, excite it to move again.

We know also another thing very peculiar concerning the irritability of this organ, viz. that it is more irritable on its internal than on its external surface ; for if instead of cutting out the heart, we leave it connected with the body, seek out (as the old anatomists were wont to do) the thoracic duct, or pierce any great vein, and blow a bubble of air into the heart, it pursues it from auricle to ventricle, and from ventricle to auricle again, till, wearied and exhausted with this alternate action, it ceases at last, but still new stimuli will renew its force.

Thus it is long after apparent drowning or other suffocation before the principle of life is gone ; and long alter the death of the body before the heart be dead ; and just as in this peculiar part of the system irritability is in high proportion, there are in the scale of existence certain animals endowed in a wonderful degree with this principle of life. They are chiefly the amphibious creatures, as they are called, needing little air, which have this power of retaining life ; no stimuli seem to exhaust them, there seems especially to be no end to the action

of their heart; a Newt's or a Toad's heart beats for days after the creature dies; a Frog, while used in experiments, is often neglected and forgotten, its limbs mangled, and its head gone, perhaps its spinal marrow cut across, and yet for a whole night and a day its heart does not cease beating, and continues obedient to stimuli for a still longer time. It seems as if nothing but the loss of organization could make this irritable muscle cease to act; or rather it seems as if even some degree of deranged organization could be restored: breathe upon a heart which has ceased to act, and even that gentle degree of heat and moisture will restore its action. Dr. Gardiner having left a turtle's heart neglected in a handkerchief, he found it quite dry and shrivelled, but by soaking it in tepid water its plumpness and contractility were restored.

Since, then, this irritable power supports itself in parts long after they are severed from the body, what doubt should we have that there is in the muscular fibre some innate contractile power or *vis insita* independent of nerves? And when we talk on a subject so difficult and so abstruse, what other proof can we expect or wish for, than the power of one peculiar and insulated muscle surviving the separation of the head and brain, the destruction of its nerves, or its total separation from that living system to which it belongs? If the heart be the most irritable muscle of the body, if all this irritability arise from the nerves, how can it be that this muscle, which is thus announced as the most dependent on its nerves, is really the most independent? that the muscle which of all the body needs this nervous supply oftenest should want it the least, and should survive the loss of its nerves so much longer than the other muscles of the same body?

Although the ancients knew how irritable the heart was, although they often opened living creatures, and saw the heart struggling to relieve itself, because it was oppressed with blood, yet they continued entirely ignorant of the cause: and why the heart should alternately contract and relax without stop or interruption, seemed to them the most inexplicable thing in nature. Hippocrates ascribed it to the innate fire that is in the heart; Sylvius said, that the old and alkaline blood in the heart mixing with the new and acid chyle, and with the pancreatic lymph, produced a ferment there; Swammerdam, Pitcairn, and Friend, thought that the heart, and every muscle which had no antagonist muscle, was moved by a less proportion of the vital spirit than other muscles required. Others believed that each contraction of a muscle compressed the nerves of that muscle, and each relaxation relieved it;

and that this alternate compression and relief of the nerve was the cause of the alternate movements of the heart: another physician of our own country, a great mechanic, and a profound scholar in mathematics, and all those parts of science which have nothing to do with the philosophy of the human body, refined upon his theory most elegantly; for observing that the nerves of the heart turned round the aorta, and passed down betwixt it and the pulmonic artery, he explained the matter thus: "These great arteries, every time they are full, will compress the nerves of the heart, and so stop this nervous fluid, and every time they are emptied (a thing which he chose to take for granted, for in truth they never are emptied,) they must leave the nerves free, and let the nervous fluid pass down to move the heart."

Des Cartes, who studied every thing like a right philosopher of the old breed, viz. by conjecture alone, supposed that a small quantity of blood remained in the ventricle after each stroke of the heart: which drop of blood fermented, became a sort of leaven, and operated upon the next blood that came into the heart, "like vitriol upon tartar;" so that every successive drop of blood which fell into the ventricle swelled and puffed up so suddenly as to distend the heart, and then burst out by the aorta. Philosophers have been so bewitched with the desire of explaining the phenomena of the human body, but without diligence enough to study its structure, that from Aristotle to Buffon, it is all the same, great ignorance and great presumption. But on this subject of the pulse of the heart, physicians almost surpassed the philosophers in the absurdity of their theories, till at last they were reduced to the sad dilemma of either giving up speaking upon this favourite subject, or of contenting themselves with saying, "that the heart beat by its *facultas pulsifica*, its pulsative faculty;" as if they had said, the jaws chew by their *mandicative* faculty, and the bladder pisses by its *expulsive* faculty, and the womb expels children by its *parturient* power.

The ancients, I have said, often opened living creatures, and saw the heart struggling to relieve itself because it was oppressed with blood: this blood is itself the stimulus which moves the whole; for important as this function is, it is equally simple with all the others: and as urine is the stimulus to the bladder, food an excitement to the intestines, and the full grown fœtus a stimulus to the womb!—so is blood the true stimulus to the heart. When the blood rushes into the heart, the heart is excited and acts; when it has expelled that blood, it lies quiescent for a time; when blood rushes in anew, it is

roused again : so natural is both the incessant action and regular alternation of contraction and relaxation in the heart.

It is when we are so cruel as to open a living creature that we see best both the operation of the blood as a stimulus, and the manner in which the heart re-acts upon it. When we tie the two vena cavae so as to prevent the blood from arriving at the heart, the heart stops ; when we slacken our ligatures and let in the blood, it moves again ; when we tie the aorta, the left ventricle being full of blood will continue struggling, bending, turning up its apex, and contracting incessantly and strongly, and will continue this struggle long after the other parts have lost their powers. One author, whether from his awkwardness, or the delicacy of the subject, or really from the strength of the ventricle, assures us, that often while he has held the aorta of a Frog close with pincers, it has burst by the mere force of the heart. If, after violent struggles of the kind, you cut the aorta, even of so small a creature as an eel, it will throw its blood to the distance of three or four inches.

Thus we not only know that we can excite the heart by accumulating blood in it, but that by confining the blood in it we can carry that excitement to a very high degree ; and in short, by keeping the one or the other ventricle incessantly full of blood, we can make the one heart work continually, while the other lies quiet, or is only slightly drawn by the other's motion, showing the true distinction betwixt the heart of the body and the heart of the lungs. And this is a memorable fact, that it is not merely the stimulus of the blood, but the sense of fulness that makes the heart contract ; for the auricle often beats twice or thrice, sometimes it makes its push four or five times, before it can force the ventricle to contract.

When we empty the heart, and tie all its veins, all its parts cease to act ; stimuli applied outwardly make it contract partially ; it trembles in particular fibres : but it is only letting in the blood, or blowing it up with air, that can bring it into full action again. When we look with cruel deliberation upon the strokes of the heart in any living creature, we observe that at first, during the full and rapid action of the heart, there is hardly any perceptible interval among the several parts ; but towards the end of each experiment, when the pulse flags, and the creature falls low, the swelling of the great veins, and the successive strokes of auricle and ventricle, are distinctly told. The dilatation and contraction of each part is what we cannot observe, they are so quick ; but these things we distinctly observe : the auricle contracts and dilates the ventricle ; the ventricle contracts, subsides, and fills the aorta ; the aorta turns and twist with the force of the blood driven into it, and

by its own re-action, and the ventricle, every time that it contracts, assumes a form slightly curved, the point turning up like a tongue towards the basis, and the basis in some degree bending towards the point. The basis, indeed, is in some degree fixed to the diaphragm and spine, but the heart in its contraction always moves upon its basis as upon a centre; its ventricles, and especially its apex, are free; the point rises and curves so as to strike against the ribs; and the dilatation of the heart is such (together with the posture and relation of its several parts) that during the dilatation the heart turns upon its axis one way; the contraction of the heart reverses this and makes it turn the other way, so that it seems to work perpetually with the turning motions of a screw. All this is most striking, while we are looking upon the motion of the heart in a living creature.

The posture of the human heart is very singular, and will illustrate this turning motion extremely well; for in the human heart the posture is so distorted, that no one part has that relation to another which we should beforehand expect. In the general system, the human heart is placed nearly in the centre, but not for those reasons which Dionis has assigned; it is not in order that by being in the centre it may feel less the difficulty of driving the blood to any particular limb or part of the body; it is the place of the lungs that regulates the posture of the heart; and wherever they are, it is. Except the Oyster, I hardly know of any creature in which the heart lies expressly in the centre of the body. In Frogs, Toads, Newts, and Snakes, the lungs are not moved by any diaphragm; and they are filled only by the working of the bag attached to the lower jaw, the lungs then begin under the jaws, and the heart is lodged at the root of the jaws, leaving, as in a Newt or Cameleon, Crocodile, Adder, Serpent, &c. the whole length of their trailing body behind. In a fish, the gills serve the creature for lungs; the gills are lodged under the jaws, and the heart is placed betwixt them. In insects, as in the common caterpillar, (the aurelia of our common Butterfly,) the air enters by many pores on its sides; and accordingly its heart is not a small round bag, but may be easily seen running all down its back, working like a long aorta, but having regular pulsations denoting it to be the heart; and this you easily see through the insect's skin, for it is more transparent along the back where the heart is.

The breast in man is divided into two cavities by a membrane named the MEDIASTINUM. This membrane passes directly across the breast from the sternum before till it fixes

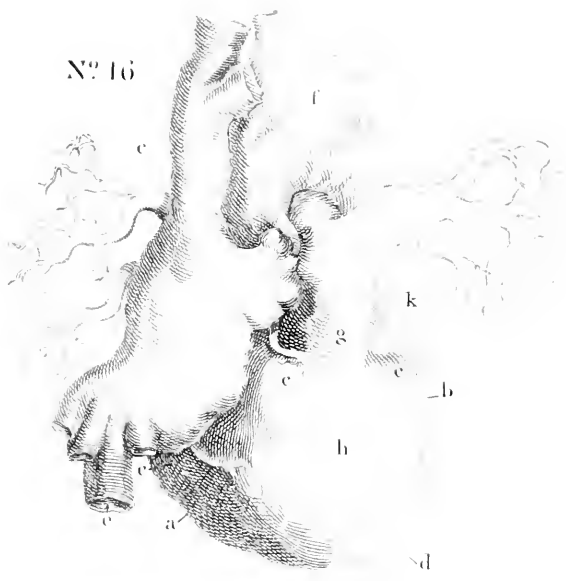
itself into the spine behind. It is on the left side of this membrane in the left cavity of the breast, that the heart is placed, lying out flat upon the diaphragm, as upon a floor, by which it is supported;* and that surface (*a*)—which lies thus upon the diaphragm, is perfectly flat, while the upper surface (*b*)—or what we usually call the forepart of the heart, is remarkable round. The whole heart lies out flat upon the diaphragm; its basis (*c*)—where the auricles are, is turned towards the spine and towards the right side; the apex (*d*)—or acute point is turned forwards and a little obliquely towards the left side, where it strikes the ribs; the vena cava (*e*)—enters in such a manner through a tendinous ring of the diaphragm,† that it ties down the right auricle to that floor (as I may term it) of the thorax; the aorta (*f*) does not rise in that towering fashion in which it is seen when we take a dried-up heart, which naturally we hold by its apex, instead of laying it out flat upon the palm of our hand: nor in that perpendicular direction in which hitherto, for the sake of distinctness, I have represented it in these plans; but the aorta goes out from its ventricle towards the right side of the thorax; it then turns in form of an arch, not directly upwards, but rather backwards towards the spine; then it makes a third twist to turn downwards; where it turns downwards it hooks round the pulmonic artery, (*g*)—just as we hook the fore fingers of our two hands within one another. The right heart (*hh*)—stands so before the other, that we see chiefly the right auricle and ventricle before, so that it might be named the anterior heart; the pulmonic artery (*g*)—covers the root of the aorta; the left ventricle (*i*)—from which the aorta rises, shows little more than its point at the apex of the heart: the left auricle (*k*)—is seen only in its very tip or extremity, where it lies just behind the pulmonic artery: and the aorta (*f*)—arises from the very centre of the heart. From this view any man may understand these vessels by other marks than the mere colours of an injection; and he will also easily understand why the heart twists so in its actions, and how it comes to pass that its posture is difficult for us to conceive, no one part having that relation to any other part which we should beforehand suppose.

* The true position of the heart is what is represented in No. 16 and 17; where No. 16 shows the heart set upright, as I have hitherto represented it in all my plans, while No. 17 represents its inclined position lying almost horizontally upon the floor of the diaphragm.

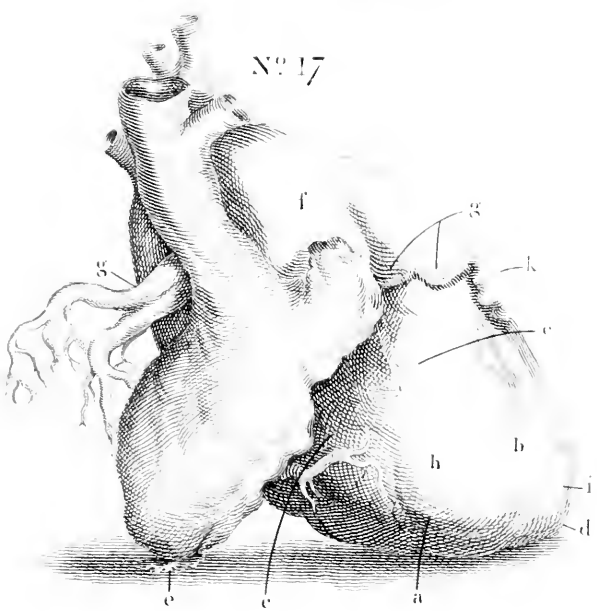
† Let it be observed, that (*e*) in this drawing, marks the point where the lower cava was tied close upon the diaphragm, to prevent the injection going down into the veins of the liver and abdominal cavity.

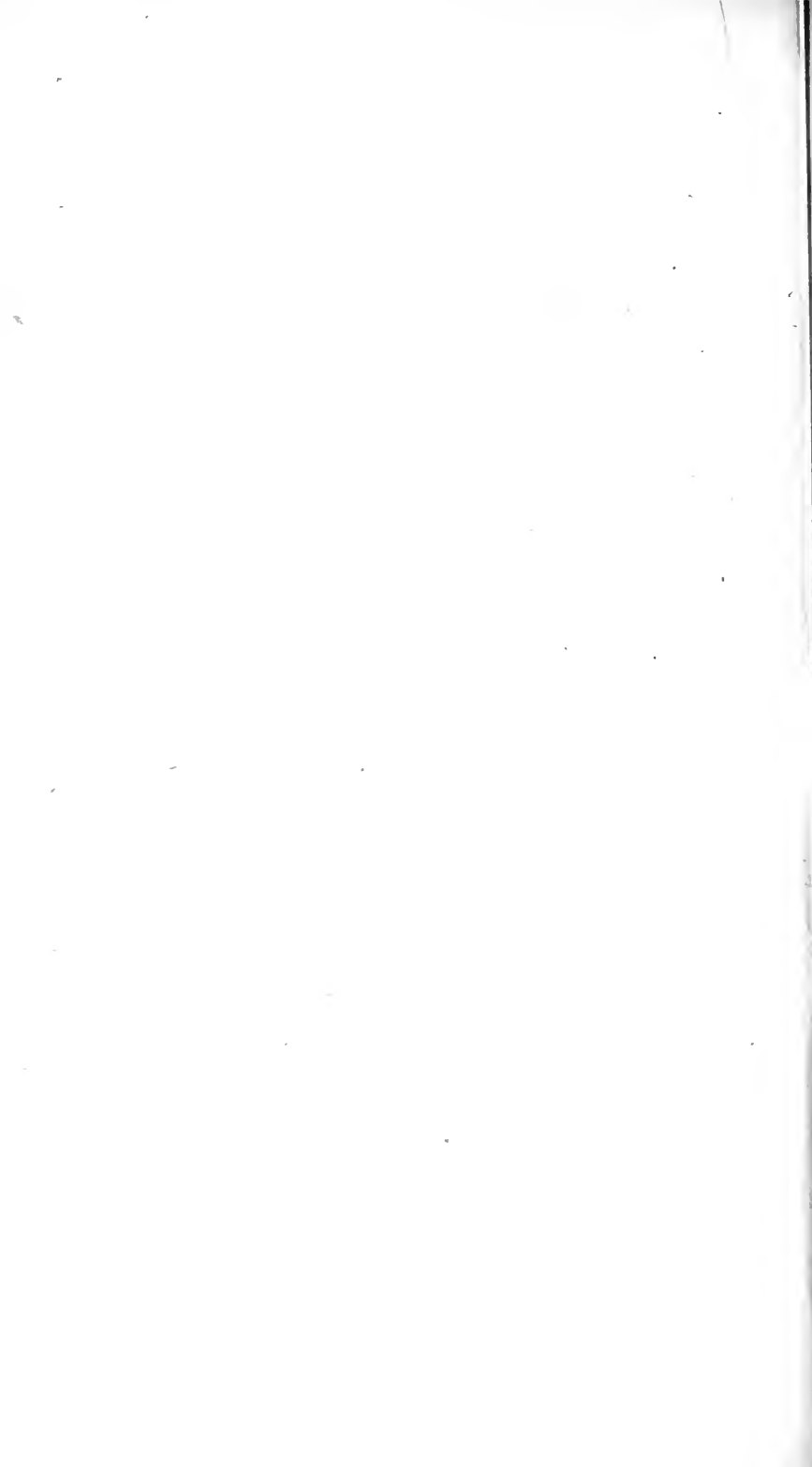
Spalding's Anatomy of the Heart

Nº 16



Nº 17







Sketches

of the Pericardium of which N 18 is a true drawing N 19 a Plan
shewing its reflexion over the Heart

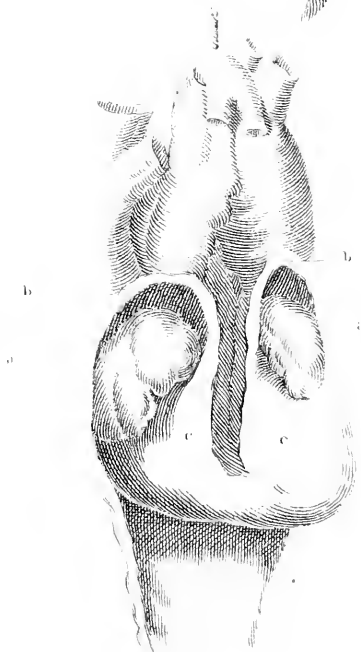
Part of the Lungs

Part of the Lungs

N 18



N 19



OF THE PERICARDIUM.

But the PERICARDIUM, purse, or capsule, in which the heart is contained, affects and regulates its posture, and makes the last important point concerning the anatomy of the heart. It is a bag of considerable size and great strength, which seems to us to go very loosely round the heart, because when we open the pericardium, the heart is quite empty and relaxed; but I believe it to surround the heart so closely as to support it in its palpitations, and more violent and irregular actions; for when we inject the heart, its pericardium remaining entire, that bag is filled so full that we can hardly lay it open with a probe and lancet, without wounding the heart; and still further, when we open the pericardium before we inject the heart, the heart receives much more injection, swells to an unnatural bulk for the thorax that it is contained in, and loses its right shape. The pericardium is formed, like the pleura and mediastinum, of the cellular substance; it is rough and irregular without, and fleecy with the threads of cellular substance, by which it is connected with all the surrounding parts; within it is smooth, white tendinous, and glistening, and exceedingly strong. As the heart lies upon the floor of the diaphragm, the pericardium, which lies under the heart, is connected with the diaphragm a little to the left of its tendinous centre, and so very strongly that they are absolutely inseparable. The pericardium surrounds the whole heart, but it is loose every where except at the root of the heart, where it is connected with the great vessels: for the pericardium is not fixed into the heart itself, but rises a considerable way upon the great vessels, and gives to the roots of the vessels, which are seen on opening the pericardium, an outward coat, and surrounds each vessel with a sort of ring, as may be seen in the plan.* For, 1st, It surrounds the pulmonary veins where they are entering the heart; there the pericardium is short: 2dly, It mounts higher upon the vena cava than upon any other vessel; the cava of course is longer within the pericardium, and it also is surrounded with a sort of ring: 3dly, It then passes round the aorta and pulmonary artery, surrounding these in one greater loop: 4thly, The cava inferior is the vessel which is the shortest within the pericardium: for the heart inclines towards the horizontal direction: it lies in a manner flat upon the upper surface of the diaphragm, while the lower surface of the diaphragm ad-

* Vide Plan, No. 1. Pl. 12.

heres to the upper surface of the liver. Thus it happens that the liver and the right auricle of the heart are almost in contact, the diaphragm only intervening; thence the lower cava which passes from the liver into the right auricle of the heart cannot have any length. While the pericardium thus passes round the great vessels, it must leave tucks and corners; and these have been named the *CORNUA*, or horns of the pericardium.

But there is another peculiarity in the form of the pericardium, which I have explained in this second plan;* viz. that the pericardium constitutes also the immediate coat of the heart; for the pericardium having gone up beyond the basis of the heart so as to surround the great vessels, it descends again along the same vessels, and from the vessels goes over the heart itself. I have marked the manner of this more delicate inflection of the pericardium at (*aa*,)—where the pericardium is loose: at (*bb*,)—the angle where it is reflected; and at (*cc*,)—where it forms the proper coat of the heart, and where it is intimately united to its substance. The pericardium where it forms this coat becomes extremely thin and delicate, almost cuticular, but strong; under this coat the coronary arteries pass along in the cellular substance; under it the fat is gathered sometimes in a wonderful degree, so as to leave very little to be seen of the dark or muscular colour of the heart.

The pericardium then is a dense and very strong membrane, which I would compare with the capsule of any great joint, both in office and in form: for it is rough and cellular without, shining and tendinous within; bedewed with a sort of halitus like the great joints, though perfect yet delicate in the child, but increasing in thickness by the continual frictions of the heart, just as a capsular ligament does by the working of its joint; and its uses are to keep the heart easy and lubricated by that exhalation which proceeds from its exhalent arteries, (and which can be imitated so easily by injecting tepid water into its arteries) to suspend the heart in some degree by its connexions with other parts, especially by its connexions with the mediastinum and diaphragm. The pericardium limits the distention of the heart, and checks its too violent actions; just as we see it prevent too much of our injections from entering the heart. How strong the pericardium is, and how capable of supporting the action of the heart, even after the most terrible accidents, we know from this: that the heart or coronary arteries have actually burst, but with a hole so small as not to occasion immediate loss of life; then the pericardium

* No. 2. Pl. 12.

receiving the blood which came from the rupture, has dilated in such a manner as to receive nine or ten pounds of blood, but has yielded so slowly as to support the heart in some kind of action, and so preserved life for two or three days.

If I have not mentioned any fluid under the direct name of *AQUA PERICARDII*, or the water of the pericardium, it is because I consider the accident of water being found as belonging not to the healthy structure but to disease. Yet this same water occupied the attention of the older authors in a most ludicrous degree. Hippocrates believed that this water of the pericardium came chiefly from the drink we swallow, which found some way or other (as it passed by the pericardium) to insinuate itself into this bag. Some after him said, it was the fat of the heart melted down by incessant motion and the heat of the heart; some said it was from humours exuding through the heart itself, and retained by the density of the pericardium, that this water came; and it is but a few years since this clear and distinct account of it was given, viz. "that it proceeds from the aqueous excrementitious humour of the third concoction." The same "sad and learned men,* *virī graves et docti*," declare to us, that the uses of the *aqua pericardii* are to cool the heart, for it is the very hottest thing in the body; or by its acrimony to irritate the heart, and support its motions; or to make the heart by swimming in it seem lighter. By this it is pretty obvious what absurd notions they had of the quantity of water that may be found in the heart. But of all the outrages against common sense and common decorum, the most singular was the dispute maintained among them, whether it was or was not the water of the pericardium which rushed out when our Saviour's side was pierced with the spear? The celebrated Bardius, in a learned letter to Bartholine, shows how it was the water of the pericardium that flowed out: but Bartholine, in his replication thereunto, demonstrates, that it must have been the water of the pleura alone. This abominable and ludicrous question, I say, they bandied about like boys rather than men: Bartholinus, Arius, Montanus, Bertinus Nicelius, Fardovius, Laurenbergius, Chiprianus, with numberless other Doctors, and Saints, were all busy in the dispute; for which they must have been burnt every soul of them, at the stake, had they done this in ridicule; but they proceeded in this matter with the most serious intentions in the world, and with the utmost gravity.† The whole truth concerning water in the pericardium is that you find water there whenever at any time

* They are thus denominated in all the charters of the College of Physicians from the time of Henry VIII. downwards.

† The shocking indecencies of their reasonings on this subject I will not condescend to draw out from the obscurity of that barbarous idiom in which it was

you find it in any of the other cavities of the body. If a person have laboured under a continued weakness, or have been long diseased, if a person have lain long on his death-bed, if the body have been long kept after death, there is both a condensation of the natural halitus in all the parts of the body, and an exudation of thin lymph from every vessel; there is water found in every cavity, from the ventricles of the brain to the cavity of the ankle-joint, and so in the pericardium among the rest. But if you open any living animal, as a Dog, or if you open suddenly the body of a suicide, or a criminal who has been just hanged, not a drop of water will be found in the pericardium. When such fluid is to be found, it is of the same nature with the dropsical fluids of other cavities: in the child, and in young people, it is reddish, especially if the pericardium be inflamed; in older people it is pellucid, or of a light straw colour; in old age and in the larger animals it is thicker, and more directly resembles the liquor of a joint.

Thus does the pericardium contribute in some degree to settle the posture of the heart; but still the heart is to a certain degree loose and free. It is fixed by nothing but its great vessels as they run up towards the neck, or are connected with the spine; but how slight this hold is, how much the heart must be moved, and the vessels endangered, by shocks and falls, it is awful to think. The pericardium is no doubt some restraint: its connexions with the diaphragm and with the mediastinum, make it a provision, in some degree, against any violent shock; its internal lubricity is, at the same time, a means of making the heart's motions more free; yet the heart roils about in the thorax; we turn to our left side in the bed, and it beats there; we turn over to our right side, and the heart falls back into the chest, so that its pulse is no where to be perceived; we incline to our left side again, and it beats quick and strong. The heart is raised by a full stomach, and is pushed upwards in dropsy: and during pregnancy its posture is remarkably changed; it is suddenly depressed again when the child is delivered, or the waters of a dropsy drawn off. It is shaken by coughing, laughing, sneezing, and every violent effort of the thorax. By matter collected within the thorax it

delivered: "Sed non cogar huc me conferre. Fateor enim nativam Christi temperiem nihil pravorum humorum produxisse, quia perfectissima; at a causis externis, vigiliis, cruciatibus, itineribus, vulneribus et mille tormentis quid non præter consuetam naturæ divinæ perfectionem productum credimus? Ad hæc sano sensu il accipiendum, nihil pravorum humorum in corpore Christi generatum." *Bartholini Epistolæ*, p. 299.—"Idque de Salvatore innoxie dixeris, quem scimus manducasse, bibisse, dormivisse, ambulasse, et quid non egisse, ut se hominem cunctis actionibus, quæ secundum naturam sunt, submitteret; sputum emisit, quum luto misceret ad curandum cæcum, et sudavit ingruente martyrio, et sine dubio non parum seri in thorace collegit, quod, aperto post mortem latere, emanavit." *Bartholini Epistolæ*, p. 300,

may be displaced to any degree. Dr. Farquharson cured a fine boy, about eight years old, of a great collection of matter in the chest, whose heart was so displaced by a vast quantity (no less than four pounds) of pus, that it beat strongly on the right side of the breast while his disease continued, and as soon as the pus was evacuated, the beating of the heart returned naturally to the left side. Who could have believed that, without material injury, the heart could be so long and so violently displaced? Felix Platerus tells us a thing not so easily believed, that a young boy, the son of a printer, having practised too much that trick which boys have of going upon their hands with their head to the ground, began to feel terrible palpitations in the left breast; these gradually increased till he fell into a dropsy from weakness, and died; and upon dissecting his body, the situation of his heart was found to have been remarkably changed by this irregular posture. Now we are not to argue that such change of posture of the heart could not happen merely from this cause, because professed tumblers have not these diseases of the heart; it were as silly to argue thus against the authority of Platerus, as to say that every post-boy has not aneurisms of the ham, or that every chimney-sweeper has not a cancer of the scrotum.

We may now close this chapter on the mechanism of the heart; in which all the parts have been successively explained. We know how the heart is suspended by the mediastinum, and by its great vessels; how it is lubricated, supported, and regulated in its motions, by the pericardium; its nerves, which remain to be explained at a fitter time, are extremely small, while its vis insita, or irritability, is great beyond that of all the other parts. We can easily follow the circle of the blood, which, as it arrives from all the extremities, irritates the auricle, is driven down into the ventricle, is forced thence into the pulmonic artery, pervades the lungs, and then comes round to the left side of the heart, or to that heart which supplies the body; and there begins a new circulation, called the greater circulation, viz. of the body, as the other is called the lesser circulation of the lungs. Thus we recognise distinctly the functions of the double heart, with all its mechanism; the stronger heart to serve the body, the weaker heart to serve the lungs; and we see in the plainest manner two distinct functions performed by one compound heart: the right heart circulates the blood in the lungs, where it is purified and renewed; the left delivers out a quantity of blood, not such as to fill all the vessels, nor such as to move onwards by this single stroke of the heart to the very extremities of the body, but such merely as to give a sense of fulness and tension to the vessels: the

force is merely such as to excite and support that action which the arteries every where perform in the various organs of the body, each artery for its appropriated purposes, and each in its peculiar degree.

By understanding thus the true mechanism and uses of the heart, we can conceive how the ancients were led into strange mistakes, by very simple and natural appearances. We understand why Galen called the right auricle the "*ultimum moriens*," or the part which died last; for, upon opening the body soon after death, he found the right auricle filled with blood, and still palpitating with the remains of life, when all the other parts seemed absolutely dead; and if the blood always accumulates on the right side of the heart before death, it is plain that the stimulus of that blood will preserve the remains of life in the right side, after all appearance of life on the left side its gone. But the cause of this accumulation of blood in the right side is very ill explained by Haller, though it seems to have employed his thoughts during half his life. He says, that in our last moments we breathe with difficulty; the lungs at last collapse, and cease to act; and when they are collapsed, no blood can pass through them, but must accumulate in the right side of the heart. That there is really no such collapse of the lungs, I propose hereafter to show; but in the meanwhile, this is the true reason, viz. that when the ventricles of the heart cease to act, and the beating of the heart subsides, the two auricles lie equally quiet, but in very different conditions; the right auricle has behind it all the blood of the body pouring in from all parts during the last struggles; but the left auricle has behind it nothing but the empty veins of the lungs; nothing can fill it but what fills the vessels of the lungs; or, in other terms, nothing can fill the left auricle but the stroke of the heart itself: but instead of acting the heart falls into a quiescent state, the left auricle remains empty, while the blood oozes into the right auricle from all the extremities of the body till it fills up.

Nothing is more agreeable than to find such phenomena described faithfully long before the reason of them is understood. In the Parisian dissections I find the following description; "Whenever the breast of a living Dog is opened by taking away the sternum, with the cartilaginous appendices of the ribs, the lungs are observed suddenly to sink, and afterwards the circulation of the blood and the motion of the heart to cease. In a little time after that the right ventricle of the heart and the vena cava are swelled, as if they were ready to burst,"* This was what deceived the ancients, and was the

cause of all their mistakes. When they found the right ventricle thus full of blood, they conceived that it alone conveyed the blood : they found the left ventricle empty, and believed that it contained nothing but vital spirits and air ; and so far were they from having any notions of a circulation, that they thought the air and vital spirits went continually forwards in the arteries ; that the gross blood which was prepared in the liver came up to the heart to be perfected, and went continually forwards in the veins, or, if they provided any way of return for these two fluids, it was by supposing that the blood and spirits moved forwards during the day-time, and backwards in the same vessels during the night.

These things next explain to us why they called the right ventricle *VENTRICULUS SANGUINEUS* ; they found it full of blood, and thought its walls were thinner, because it had only to contain the very grossest parts of the blood ; and why they called the left ventricle *VENTRICULUS SPIRITUOSUS* and *NOBILIS* because they saw it empty, and concluded that it contained the animal spirits and aerial parts of the blood, and its walls were thicker, they said, to contain these subtile spirits. They explain to us their names of *ARTERIA VENOSA* and *VENA ARTERIOSA* ; for they would have veins only on the right side of the heart, and arteries only on the left ; and although they saw plainly that the pulmonic artery was an artery, they called it *Arteria Venosa* : and although, on the left side again, they saw plainly that the pulmonic vein was merely a vein, they would still cheat themselves with a name, and call it *Vena Arteriosa* : the veins, they said, were quiet, because they contained nothing but mere blood ; the arteries leaped, they said, because they were full of the animal spirits and vital air.

The very name and distinction of arteries which we now use, arise from this foolish doctrine about air and animal spirits. To the oldest physicians there was no vessel known by the name of artery, except the *ASPERA ARTERIA* ; and it was named *Artery* because it contained air ; so that Hippocrates when he speaks of the carotids, never names them arteries, but calls them the leaping veins of the neck. But when Erasistratus had established his doctrine about the vessels which go out from the heart, carrying vital spirits and air, the name of artery was transferred to them ; and then it was that the ancients began to call the vessels going out from the left side of the heart, arteries, naming the aorta the *ARTERIA MAGNA* and the pulmonic vein the *ARTERIA VENOSA*.

When a vein was cut, they saw nothing but gross blood, and of a darker colour ; but when an artery was cut, they observed that the blood was red ; that it was full of air bub-

bles ; that is spurted out, and was full of animal spirits ; and thus it became easy for them to show how safe it was to open a vein where nothing was lost but gross blood, how terribly dangerous it was to open an artery which was beating with the spirit of life : and this they considered as such an awful difference, that when arteriotomy in the temple was first proposed, they pronounced it murderous, and on this reasoning it was absolutely forsaken for many ages.

But the oldest of our modern physicians soon found a necessity of mixing this blood and animal spirits together, and for a long while could hit on no convenient way by which this mixture might be effected ; as a last shift, they made the blood exude through the septum of the heart ; and then the current doctrine was, that of the blood which came from the liver, one half went into the pulmonic artery to nourish the lungs ; the other half exuded through the septum of the heart, to mix with the animal spirits. Riolanus was the bitter enemy of Harvey and of his noble doctrine ; and this is the miserable and confused notion, not to call it a doctrine, which he trumpeted through Europe in letters and pamphlets. To make good this miserable hypothesis, Riolanus, Gassendus and many others, saw, the necessity of having side passages through the septum of the heart. I really believe from their mean equivocating manner of talking about these passages, that they had never believed them themselves.* “The chyle,” says Bartholine, “and the thinner blood, passes through the septum of the heart, when the heart is in systole and the pores and passages are enlarged.” Thus did the celebrated Bartholine believe the septum perforated. Wallæus, and Merchetti, and Mollinettus and Monichen, believed it, and Mr. Broadbecquius of Tubingin proved it.† But I believe most potently with Haller, that whenever they wanted to show those perforations, they managed their probes so as to make passages as wide and as frequent as the occasion required : “Solebant foramina parare adigendo stylos argenteos in resistens septum,” says Haller ; and this is a full and true account of all the authors who have described side passages through the septum of the heart ; they needed them, and they made them.

Amidst all this ignorance, we cannot wonder that a thousand childish imaginations prevailed, nor that the qualities of the mind were deduced from the physical properties of the

* That I may not seem to speak too harshly of this knot of conspirators against Harvey, I will quote what Boerhaave says of Riolanus, who was at the head of them ; “Non ipse callidus cavillationum artifex Riolanus,” &c.

† Experimento perforatum ostendit Broadbecquius Tubingæ.

heart. We have heard the vulgar, for example, speak of the bone of the heart. And from whom did this arise? From Aristotle! who explains to us, that there is at the root of the heart a bone which serves for its basis; and not a physician has written upon the heart since his time who has not spoken more or less mysteriously about this bone; while in truth the whole story means nothing more than this, that where the basis of the arteries are fixed into the hard ring or basis of the heart, the place is extremely firm, almost cartilaginous, especially in old age, when often the roots of the arteries are ossified or converted into what anatomists have chosen to call bone.

Often also we have heard the vulgar talk, not figuratively, but in the plain sense of the words, of a little or big heart, as synonymous with a timorous or courageous heart. But whenever we hear mistakes of this kind among the vulgar, we may be assured they have some time or other come from high authority. Bartholine was so much convinced that a small heart begot courage, and a great one irresolution and fear, that he is thoroughly surprised when he finds the contrary; "*Cor vastus fuit homo, tamen audax fuerat, ut cicatrices in capite frequentes et rimæ in cranio testabantur.*" But if Bartholine be right, Kirkringius is quite wrong, and has mistaken the doctrine; for he says, "*An magnanima fuerit hæc magni cordis fœmina, nescio,*" &c. "I do not know whether this woman's courage was as big as her heart; but this I do know, that she was a famous toper. Whether this drinking dilates the heart, and makes your staunch drinkers such famous fighters, I cannot pretend to decide." We have heard the vulgar talk also of a hairy heart, as familiarly as a hairy man, being the mark of high courage and strength; but what shall we think of it, when we find that this report is to be deduced fairly from Pliny, through the most celebrated names among our old physicians? He it was who began with telling how the Messinians, that unhappy people, who lived for so many ages the slaves or helots of Greece, lost their great general Aristomenes. But how great he was, never, according to Pliny, come to be known till after his death; for the Lacedæmonians having caught him three times, resolved at last to open his breast; and there as a proof of his most invincible courage and daring, they found his heart filled with hair. This from Pliny was nothing, if such dissections had not been made since then a hundred times. "There was a robber, (says Benivinius,) one Jacobus, who having been taken down from the gibbet apparently dead, but really having in him the remains of life, was laid carefully, recovered, was

perfectly restored, betook himself to his old ways again ; and so in the natural course of things came round to his old mark the gallows, and was this time very thoroughly hanged. Wondering (says Benivinius) at the perfect wickedness of this man, I longed very anxiously to dissect the body, and I actually found the heart, not covered, but (*refertum pilis*) crammed with hair."

But there is, in fact, no end of wonders and wonderful dissections among these robbers of his. His next subject was not a bold robber, but a poor sneaking thief (*de corde furis cujusdam*;) there was no hair to be expected in his heart ; but as he was a thief only, it was consistent with this doctrine that he should be first very heartless ; secondly, have very little brain ; thirdly, that he should have very inordinate appetites and desires. Now there was first a great two-legged vein carrying the *atrabilis*, the source, no doubt, of all his inordinate cravings, directly into the stomach. Secondly, there was a great abscess full of pus wasting the left side of his heart ; and, thirdly and lastly, the back part of the head (which all the anatomists of that time knew very well was the seat of memory) was in him so small that it could hardly contain a spoonful of that kind of brain ; and this want was the reason (having so little memory) that he was so persevering a thief ; for let you whip him, banish him, clap him in the stocks, he forgot it straightway, and was back at his old tricks again, like a dog to his vomit.*

But these are now almost forgotten, though perhaps the history of the absurdities of the human genius should no more be neglected than of its beauties. Is it not delightful to feel, that after floating in this ocean of conjecture, after all these disorderly and wild dreams, we are come to have an idea of the heart, simple and beautiful ; of a heart containing within itself two functions ; first, the office of renewing the blood ; secondly, the office of animating the arteries, and by them preserving in life and action the whole system of the body ? These are the two offices which I shall now proceed to explain.

* "Non videntur silentio esse prætereunda, quæ nuper in inciso Jacobi cujusdam furis insignis cadavere annotavimus ; bifurcatam scilicet venam quæ a liene ad ventriculum atram deferit bilem, tum et abscessam in sinistro cordis ventre pituita redundantem ; postremo et posteriorem ejus capitis partem, ubi memoriæ sedes est, adeo brevem, ut tantillam cerebri portiunculam contineret. Quam ob causam, cum priorum scelerum et eorum quæ pro his sæpe passus fuerat, tormenta scilicet, exilia et carceres minime recordaretur, toties ad vomitum tanquam canis impudens reversus est, at in laqueum tandem inciderit, vitæque ac furti finem fecerit."

—Vid. *Benivinius*.

CHAP. II.

ON THE APPEARANCE AND PROPERTIES OF THE BLOOD, ON THE CHEMISTRY OF OUR FLUIDS, AND ON THE INFLUENCE WHICH AIR HAS UPON THEM.

BY the simplest methods the blood can be resolved into various parts, but chiefly into these three ; the red globules, which give colour to the blood ; the gluten, which gives consistency and nutritious qualities to the blood ; and the serum, which dilutes, mixes, and suspends the whole.

Though the serum and gluten did not pass entirely unnoticed the red globules were the part of the blood which first excited the attention of physicians, and seemed to promise a rich harvest of discoveries ; a promise which too surely never was fulfilled. The red particles have always appeared important, because they seem to give the colour, the useful qualities, and the whole character to the blood. It is by the rolling of the red particles only that we see the circulation in the microscope ; it is red blood only that we ever name as blood ; and the colour of the red blood changes in health and disease. But when physicians studied this part alone, when they gave it the mark of chief importance, and annexed to it alone the name of blood, they little thought how far they over-rated its importance, how far the red particles are from nourishing the system, from being essential to the blood, from being universal in all creatures. They had not considered what myriads of animals, great as well as small, want the red particles, and (if these red particles are to be the characteristic) want blood ; while philosophers of less contracted notions have continued to call that fluid blood, which fills the vessels of plants.

The Harveian doctrine had no sooner produced a revolution in the general doctrines of physiology, or physicians begun to think of the heart and its circulation, of the great arteries, and extreme vessels, of the difference betwixt arteries and veins, and of the ways in which the fluids move through the smaller tubes (for they saw them moving by their microscopes :) no sooner did all these phenomena and new wonders present themselves to their imaginations, than they thought also of curious ways by which these motions and secretions might be explained. They then began to estimate the calibres

of the arteries, to calculate with great affectation of care the shape, the size, the composition, as they choose to call it, of the particles of the blood; chimeras and fancies sprung up innumerable; and it happened unfortunately that for a long while physicians studied nothing but angles, and logarithms, and algebraical equations; they reasoned according to those sciences only which have no connexion with the physiology of the animal body; they calculated the force, the thickness, the dimensions of the heart; the diameter, and the strength of walls, and the direction of the aorta; their experiments consisted in fixing clumsy tubes into the arteries, or in calculating the whole quantity of blood by bleeding an animal to death; they applied nothing but the laws of hydraulics, (*i. e.*) of fluids rising and falling in rigid tubes, to explain the active arteries of a living body: in short, in explaining the living body they forgot that it was alive. But now the age of infallible proofs and demonstrations has passed over, and the works of Keill, Pitcairn, Borelli, are quite neglected.

This disordered and miserable state of science, which continued for a century nearly, arose from those red particles of the blood engrossing too much attention, and from their being allowed an importance which does not belong to them; although one must still acknowledge that they are very surprising, because they are very unaccountable, at least: do not know that any natural or likely use for them has been yet assigned.

Leeuwenhoek, looking through his glasses, saw that this which gave the red colour was the most permanent characteristic part of the blood; he saw that this part consisted of red particles floating in the serum; he found, or pretended to find, that they were of the same size in a man as in a fœtus; in a chick as in a hen; in a whale or elephant, he found them the same as in a mouse or minnow; merely because it was convenient for him to find it so.

But poring still longer over these particles, he perceived that the great globules were so far imperfect as often to break in pieces, and roll about in the serum in separate parts; and he always found that there were six less parts composing the greater globule of the blood. By looking more and more, he pretended to observe, that these smaller parts into which the red globules broke down still preserved their form; that these were the particles of the serous part of the blood; and that the great or red particles frequently broke down into serous particles, and these again as frequently united and composed afresh a red globule. He pretended to find, that exactly six smaller globules went to make up one great one; and he

called the red and serous globules the globules of the first and second order.

By this notion of orders it was plain that he intended to plunge deeper into this hypothesis, and to have at least a third and fourth order; besides, these orders and particles were at his call, he might do as he pleased; and he was almost the only person possessed of glasses which could enable the physiologist to see and tell about them. He pored till he believed or at least made others believe, that he saw globules of a third order, six times smaller than the serous globules, and of course thirty-six times smaller than the red globules. And thus he had lymphatic particles, six of which made up one serous particle; and serous particles, six of which made one red globule.

To the geometrical physiologists of that day all this instruction concerning the structure of the blood was most delightful; it corresponded very notably with their calculations about regularly descending series of vessels; and a most curious method did they find out for settling this law of the branching of arteries. They took the plates of Eustachius, measured with compasses the arteries and veins, estimated the angles at which each branch goes off, compared the several branches with the parent trunk; and from such calculations they settled the general law as heartily and freely, as if, instead of the most extravagant plates in all anatomy, they had been measuring actually the human body itself. Thus they had set up their doctrine of angles, branches, anastomoses, trunks, and extreme vessels: they had found that there was a regular series of descending arteries; they had a tube now suited to every descending particle that Leeuwenhoek could invent; and when a particle had got into a wrong vessel, it could go back till it found a tube that suited it: or if driven into a wrong bore, it could break itself down into serous or lymphatic particles. But when many particles did stick hard in the straight places, then there was an error loci; then the big particles were out of their peculiar vessels, and then the part began to be red: thence came inflammation, fevers, deeper obstructions: and from such causes, or from the breaking down of the blood and humours, came every disease that could be named.

So very greatly were they delighted with the discovery, that Dr. Martin, who had measured the vessels, as I have just told, and had dreamt over this the longest and soundest of them all speaks of it in these rapturous terms. "But we are moreover certain from the observations of that most accurate and curious observer of the *minima naturæ*, that there are innumerable

vessels of such a smallness that none of these globules could pass; so that it is necessary to suppose inferior classes of globules of the fourth, fifth, sixth, and other orders.—Whence by analogy we are to conceive globules of the third order made up of six globules of the fourth order, and these of six of the fifth order, and so on ad infinitum through various degrees, the number of which we are not to take upon us to determine.” This is a pleasant addition of Dr. Martin’s; and makes it a most manageable system of most dilatable materials, stretching so as to suit all occasions. This rider or codicil to the doctrine made it easy for every particle to pass every vessel; but, alas! it leaves no room for that old catchword of the system, the error loci, nor any provision for making diseases.

How all the physicians in Europe could digest this absurdity, of yellow particles, by aggregation and arrangements in sixes and sixes, becoming red, is not easy to conceive; nor is it easy to conceive how men, whose education in mathematics and algebra should have taught them to think accurately and reason closely, could believe that globules should break down into six particles each, and that these particles, being themselves particles of serum, should yet be distinctly seen floating in the serum. How could these geometrical physicians possibly believe, that these particles, from large to small, should descend, not gradually and imperceptibly, but by sixes and sixes, one after another like steps of stairs? In all his mathematics, I do not believe that Martin could find any contrivance fit to help him out of these difficulties. Martin observes, in his own way of geometry, and proceeds to prove it by most laborious schemes, “that just six small sphericles should go to make up one larger globule, if you were to choose the most convenient and firmest way of constructing it;” and then he wonders at Leeuwenhoek finding it exactly so. But if Leeuwenhoek knew this as well as Dr. Martin, I cannot for my heart think it any wonder that Leeuwenhoek chose “the most convenient and firmest way of constructing a red globule, viz. out of six smaller ones.” Seeing that he had the affair entirely in his own hands, “what a beautiful HARMONY and REGULARITY do we perceive,” says Martin, “in the mass of blood! Magnum certe opus oculis video.” In plain truth, they desired but a little of this harmony, a little consistency in their doctrine, and all was well.

But the mistakes concerning the formation or organizing of this blood are worse than these; for they came from men truly learned, and diligent in anatomy, led on by too strong a desire of finding out the uses of several parts of the human body, as of the spleen and thymus, parts hitherto unexplained. Mr. Hewson supposed that the lymphatic glands, which seem at first to

be mere convoluted vessels, but which being injected with mercury, and cut into, are seen to consist of numerous cells, form in these cells the primordia of the red blood; for each red particle he supposes to consist of a central particle, which is solid and dark-coloured, surrounded by a vessicle which is transparent or white; and this dark or central part he supposes is formed in the lymphatic cells; for he finds a sort of round particles in the lymph, and often he finds the lymphatics full of red blood.

Next, he has supposed that in the child there is required a much greater supply of blood: for this purpose is the thymus appointed; viz. to assist the lymphatic glands in organizing blood. This gland lies in the upper part of the chest, is great in the child, has vanished in the adult, but while it exists, he finds it full of a milky juice or whitish mucus, fit to make central particles for the blood; and the lymphatics, as he supposes, are the excretories for this gland. He next conjectures, that this work, begun thus by the lymphatic glands, and thymus, is perfected by the spleen; that the lymphatics make central particles only, while the vesicular coverings are formed in the spleen; so that there only do the particles become perfect; and accordingly of these parts it is in the spleen alone that the red blood is found.

As the central particles are formed in the cells of the lymphatic glands, the vesicular parts are formed in the cells of the spleen, and the lymphatics unload these cells of the particles when completely formed; but there appears no other proof that they do this office than that there are cells in the spleen which may make vesicles: and that the lymphatics being tied, and the spleen squeezed, red globules are sometimes found in them.

Long poring over a wearisome subject, and an intense desire to finish that account of the blood which he had so successfully begun, are strong apologies for all these mistakes. No man will venture to deny, that the glands and lymphatic vessels probably accomplish some important changes upon all fluids which pass through them; but that they alone organize the blood, is not to be conceived. Their containing round white particles, argues nothing; these exist in the chyle, and probably in that condition pass into the blood. But if the fœtus requires a great supply of blood, and the thymus assists the lymphatic glands, how comes it when both lymphatic glands and thymus are working in concert to prepare a great quantity of blood, that the spleen, which is to finish all these particles, and to make vesicles for them, is not in a child as big as its liver is?

That red globules are found in the lymphatics, and most especially in the lymphatics of the spleen, is a most ordinary occurrence, and quite intelligible. There are not found any where, not even in the spleen, imperfect globules advancing in their organization; on the contrary, those which we do find are full formed globules which have been forced out of the common line of circulation; they are extravasated, and taken up by the absorbents before death; or they are squeezed into them by handling after death. If we want to have an example of the first, we have but to inflame a part and tie up its lymphatics, and then many red particles are found in them: the second we see every time we either look for, or prepare the lymphatics of the spleen, or of any other soft viscus; for by handling and squeezing, the blood passes through the small breaches occasioned by this violence into the lymphatics; if we allow the part to spoil, then air is generated, and by handling it, air passes into the lymphatics in the same way.

But the spleen is essential to finish the work; it makes the vesicles, and has cells for the business; and yet this part, which has the most important of all offices, viz. that of organizing the general mass of blood, may be cut out from dogs and other animals, and they never feel the loss, nor decline in health. There is not the smallest doubt that the spleen has protruded at wounds, and been strangled, and so cut off. Every day we find it more or less diseased; sometimes it has swelled to thirty or forty pounds; sometimes it has been reduced to an extremely small size; sometimes it has been found like an empty bag.

In the fœtus, as in a chick, for example, red blood circulates in great profusion long before its lymphatics, spleen, or thymus, can be seen to exist; whereas, on the contrary, since the chick is insulated, and has no red blood from the mother, the spleen should have been first coloured, and all the red blood of the system should have emanated from the spleen.

It is but a poor evasion to say, in answer to these objections, "some other part may perform this office of the spleen." What other parts will perform the office of the liver, if it be wanting? or of the kidney, or of the testicle, or of any other gland? or will the testicle secrete urine, or the kidney secrete bile? What gland, then, will be able to perform so peculiar an office as this of adding vesicles or coverings to the central parts of the blood?

After all this long dream about the vesicles and their central parts, the best physiologists of the present day seem to deny that they exist.

But one author has finished this career of useless specula-

tion by maintaining that the LIFE is in the BLOOD: and thus we have seen this simple and beautiful subject of the blood tortured through all kinds of imaginations, and running its fiery ordeal, first through mathematics, then through anatomy and all its glands, then through metaphysics; till at last we are come to talk with the most perfect ease and confidence about the most monstrous of all absurdities, the life of the blood.

"For in the blood is the life thereof," might be a useful doctrine among the Jews, if it moderated their desire for blood; and if among physicians this were to be the tendency of such a doctrine, it were very cruel and unnatural to disturb it: but in serious earnest, it introduces into modern physiology nothing but a jargon of words, and prevents every idea that the mind of man can form of parts which excite and parts which act. Whimsical theories creep faster into physic than useful facts; and the business is fairly enough begun when surgeons, dissecting aneurisins of the carotid arteries, and who should be employed in recording how and from what causes they have arisen, or how such diseases affect the arterial coats, choose rather to inform us "that this state of the blood, or rather of the coagulable lymph, may arise from some connexion or sympathy it may have with the diseased state of the artery." "By lightning, (says a celebrated author,) death is so instantaneously produced in the muscles, that they cannot be affected by the stimulus of death." Connexions, and unknown sympathies, and living powers in fluids, and energies, and efforts, and intentions, and "sympathetic congelations in the blood," and "immediate sympathetic contiguous harmonies, of cut parts," and the "diffused principle of life," and "the stimulus of death;" are words which physiology would gain by losing, and are the very cant belonging to the doctrine which I propose to refute.

It is not merely the doctrine of a living principle existing in the blood that is now to be spoken of, but a doctrine attributing the life of the solids to this living principle of the blood; so that it may be entitled "the new theory concerning the blood, which is itself alive, which gives life to all the other parts, and which in the beginning forms all the parts out of itself in the mother's womb; so that a fœtus is merely a speck of blood, and all the parts being formed from that speck of blood, the whole of physiology is abrogated henceforward, and totally annulled, except this theory itself. It is like the staff of Moses converted into a serpent, which ate up the serpents of all the magicians who had thrown down the staff before him; for if the theory were once established, there would

remain nothing to be done in all the animal body but what was done by the blood ; nothing to wonder at, nothing to guess about, nothing to study, but this vital and plastic power of the blood.

The author of this doctrine shows us two or three specks in an incubated egg ; he tells us that they are dots of blood ; he tells us that this blood forms the vessels in which this blood itself is to move ; it forms the limbs of the chick which these vessels are to serve ; the bones, muscles, bowels, glands, the whole creature is formed out of it ; and when the bird is delivered from the egg, the living principle of the blood still continues to support it. The blood heals its flesh or bones when they are broken ; “ the blood moves in the living solids, which it both forms and supports.”

It is not easy to say on which of all his proofs, Mr. Hunter chiefly relies for establishing a doctrine so important as this is ; whether he considers it as a perfect proof of the vitality of the blood that it coagulates, or that this coagulum has moreover the power of becoming perfectly alive, and of forming new vessels within itself ; or that blood seems to assist the union of contiguous parts ; or that by taking away its blood a creature dies ; or that a limb falls into immediate gangrene when its vessels and its supply of blood are cut off. But chiefly he seems to rely on coagulation as a proof of the vitality of the blood ; for he considers the coagulation of the chyle as a proof that it also is alive : and he says, “ contraction is the life of the solids ; and if we can find any thing like it (by which he means coagulation,) we shall call it the living principle of the blood.”

But what harmony he can find betwixt the occasional voluntary, regulated, contractions, of the living solid and this sudden, irritable, inorganic, coagulation of the blood, I cannot conceive. Does not jelly coagulate ; and what is it but a part of the blood ? Does not glue congeal, dissolve, and congeal again, yet what is it but an animal jelly ? Does the blood itself ever congeal till it is out of the body, or extravasated in aneurismal sacs ?* When it is out of the body it coagulates ; when it coagulates, it is dead : coagulation is so far from resembling the contractions of the living body, that it is the marked character of dead animal matter, which you melt and coagulate again and again. Shall we then define life by saying, coagulation is the mark of the vital principle ? If so, we give the mark of its death as the proof of its living power.

But in his awkward attempts to prove this point, the author

* From the most recent inquiries no jelly appears to be in the blood. C. B.

has brought himself into great suspicion, and of course into great dishonour, by two experiments, in which he endeavours to show how this vital power, like the life of a perfect creature, is affected by cold first. In page 79, we are informed, that a fresh egg, in consequence of being alive, resists the cold, and is frozen with great difficulty ; but being once frozen and thawed again, it loses its living principle and its power of resisting cold at once ; it freezes now at the same temperature with other animal matter, showing no longer any power of generating heat or resisting cold.

But we are told,* that the blood having a determined period for coagulating, you may during that time freeze the blood, and it will thaw again, and yet congeal at its proper time ; and he tells us, that he had very cleverly frozen blood in the very time of its flowing from the vein, then thawed the cake, and still in due time it congealed. Now since the egg resists cold by its living principle, why did it die or lose that living principle when converted into ice ? or rather since the blood coagulates through its living principle, and by a living effort, how did it preserve its living principle after being frozen ? This proves surely, either that the blood's coagulation has no relation to any living principle, and therefore is not affected by the cold : or that the egg has a living principle of a very different kind, which is absolutely and totally extinguished by cold. I am sure that had Mr. Hunter seen these two experiments brought face to face in this manner, he would have put one of them at least back quietly into the portfolio from which they both came. I have always observed, that your great tellers of experiments need to have good memories ; and I am come to look on a suite of experiments as coolly as upon a set of neat plans and figures by which the author chooses to illustrate his hypothesis.

That this coagulum, being once formed, has the power of becoming more perfectly alive, and forming vessels within itself, it is not easy to conceive. Nothing indeed is more common than clots of blood, or depositions of the coagulable part, becoming highly vascular, by vessels shooting into them from surrounding parts ; but this is of no value in Mr. Hunter's doctrine ; this is not the fact which he means to speak of ; this is much too natural and easy for him ; and that his meaning may neither be misrepresented nor mistaken, I quote his words ; "When new vessels are formed, they are not always elongations from the original ones, but vessels newly formed, which afterwards open a communication with the original." That a clot of mere blood should have in it

a living principle, and should possess through that principle the power of forming within itself arteries and veins, a new and independent circulation; that it should have the privilege of knowing when it should exert itself thus, is really wonderful; that it should have some kind of intelligence, or consciousness, by means of which it could understand when it were within and when without the body; and whether in certain circumstances it were fit that such vessels should be formed! That clots should have been busied forming vessels within them for ages, and no body ever have seen the process going on! That Mr. Hunter, who has been looking out for vascular clots for thirty years, never should have seen this phenomenon is all very surprising. Mr. Hunter falls into a deeper blunder in this business than in the affair of the frozen egg; he absolutely never saw a proper vascular clot. He informs us most deliberately in page 92, "that he thinks he has been able to inject what he suspected to be the beginning of a vascular formation in a coagulum, when it could not derive any vessels from the surrounding parts." From whence then did this clot derive its injection? This is a question which detects at once what Mr. Hunter was doing, and puts this experiment pretty much upon a footing with the frozen egg.

To say "that the blood, in some circumstances, unites living parts by a sort of contiguous sympathy as certainly as the yet recent branches of one tree unite with another," is to put forth a syllogism, in which both major and minor propositions are untrue. First, it is not true, that it is the juices of the tree which unite the graft to the stock; it is the living fibres, and the living vessels of both; and unless both be alive, the process must fail, living juices would do no good. Secondly, though the juices did so unite or glue together the branches of a tree, that were no proof of the juices being alive; but only that good juices, whether alive or not alive, were necessary to the process.

Any man who affirms that in surgical operations it is the blood, "that by a contiguous sympathy unites the parts," should have supported his assertion by this further argument, that without blood they will not unite. Prove to me only that fresh cut parts are not alive, and cannot naturally unite without the assistance of some foreign power, and then I will acknowledge willingly that they are altogether beholden to the inter-mediation of the blood, with its living principle, and sympathy of contiguity.

But it is very singular that any person, even the least instructed in forms of reasoning, should have advanced this as

any proof of living principle in the blood, "that mortification immediately follows where the circulation is cut off;" for this proves merely, that the blood is one of many stimuli, by which the system is supported, inasmuch, that each limb is affected just as the whole body would be; and whether you stop the blood, which is one stimulus, or take away its heat, which is the stimulus next in power to the blood, the limb will equally die.

To say that the life is in the blood, because the blood being taken away the limb dies, or because an animal may be bled till it dies; what is this but to jumble all distinction of cause and effect? The water, no doubt, is the life of the mill, and the plough-horse is the very life of the plough; for the mill and the plough are dead the moment that the horse is gone or the water fails.

Lastly, we are told "that it is by the contiguous sympathy of the blood and body both being alive," that they both work upon each other mutually: but it is not very strange for any physiologist to forget, that the blood is at least in part a foreign body, that it must be continually impregnated with air, that it is neither its original constitution, nor these presumed sympathies that make it vital blood, that it becomes vital blood only by exposure to air, and that if this foreign principle be not continually added, the solids are not wrought upon by the blood?*

The natural difficulties of this doctrine are very great; for it seems to be against all the laws of nature that any fluid should be endowed with life. A fluid is a body whose particles often are not homogeneous, have no stable connexion with each other, change their place by motion, change their nature by chemical attractions and new arrangements; a body which can have no perfect character, no permanent nature, no living powers connected with it. But the definition of a solid is the reverse of this; a solid among every kind of metals, earths, or fossils, is recognized by its peculiar form and arrangement of parts: and in the animal body, the arrangement of particles gives the permanent unchanging character of each part; and in the muscles, for example, or in the nerves, where feeling and irritability chiefly reside, the form and mechanism of the solid is in each most peculiar, and is always the same.

What is this blood that it should begin life and support it and distribute it through all the system? It is not a fluid which varies every hour, now richer, now poorer, now loaded with salts, now drowned in serum, now much, now sparingly supplied with air, now darker coloured, now red, now fully sup-

* There is no proof that oxygen is absorbed in respiration, but only carbon removed.

plied with chyle, and now starved of its usual supply? Is it not lost in astonishing quantities in hæmorrhages, and drawn very freely from our veins upon the slightest disease? That such qualities are consistent with life in the blood, is what I cannot believe. But I can most easily imagine how the system, having by successive operations converted the food into chyle, the chyle into blood, and fashioned the nutritious part of the blood into various solids: these new solids may partake of the vitality of all the parts to which they are applied, and to which they have been assimilated by so peculiar and so slow a process.

The question is plainly this: Shall we follow the general laws of the system, such as physiology acknowledges? or shall we admit an absurd novelty without proof? Shall we allow of the simple accident of coagulation (an accident common to dead fluids) as a proof of life? or shall we forget those stupendous proofs of the irritability residing in the heart, muscles, and other forms of our living solids, and which is the source of all the various actions of the body? Shall we forget that polypi, worms, insects, the bloodless parts of fishes, the uncoloured parts of the human body, even plants almost inanimate, all partake of life, without having red blood in their system, or having it restricted to the central parts? All these have life and vitality, but where is their blood? In short the question plainly resolves itself into this, Shall we have two living parts, fluid and solid; two agents acting on each other? or shall we follow the common law of the æconomy, call the one an exciting power, while the other receives that excitement, being alive only that it may feel and act according to the degree in which it is moved? Shall we have the blood communicating life to all the body; or the body only alive, and the blood, like various other excitements, acting upon it with those powers which it is continually acquiring, without acquiring along with them any share of life?

But Mr. Hunter, ill contented with his doctrine himself, he even who began with giving to the blood a vital principle, and calling it the former of new parts, and the substance whence the living solid derives its life, hatches a new doctrine out of the confusion of the first; takes from the blood all those high privileges in the system which he had so freely bestowed upon it, and gives them in full perpetuity to a new principle, a principium vitæ diffusæ, which he announces thus:

“I would consider that something similar to the substance of the brain is diffused through the body, and even contained in the blood; and between this (*viz.* the matter diffused in the blood) and the brain the communication is kept up by nerves.”

This matter he does not like to define, but he must name it ; and having observed, as others have done, that a mouthful of nonsense sounds infinitely better in Latin than in our mother tongue, he calls it the "*Materia vitæ diffusa*."—Concerning this diffused principle of life, he tells us, that every part of an animal has its due proportion ; it unites all the body into one ; " it is as it were diffused through the whole solids and fluids making a necessary constituent part of them, and forming with them a perfect whole."—The terms in which this doctrine is proposed are hardly more intelligible than those in which he argues about the life of the blood ; the matter itself resembling the substance of the brain, is supposed ! the manner of its union with the blood is supposed ! its connexion at once with the fluids, and with the living solids, is supposed ! the sort of a manner, in which this matter harmonizes the whole, is supposed ! and now the coagulation, and life of the blood, is no longer an effort of the life of the blood, but of the *materia vitæ diffusa* ; and the blood does not form the solids, the blood no longer communicates life to the solids, but the blood and the solids are both at once animated by this DIFFUSED PRINCIPLE OF LIFE.

No one need triumph over a doctrine which thus falls by its own weight ; but this must not be forgotten, that the doctrine of the life of the blood leads to a mean contracted, narrow view, not merely of this but of higher subjects.

Plants have active and irritable fibres ; by the most curious actions they drink in water ; water alone they can convert, by the most simple mechanism, into most delicate perfumes, into delicious fruits, or into terrible poisons. " There stands" says Blumenbach, " a hyacinth before me ; generations of these flowers, of which this is the last, have grown there successively, touching the surface merely of a little water ;" but shall Mr. Hunter persuade me that this water is alive ? "*vel hyacinthi me monent.*"*

I think I may safely conclude, that these theorists have done the science no good ; themselves no honour ; and us no kind of benefit, unless it be an advantage to know that by none of these ways can we arrive at a knowledge of the blood.†

QUALITIES OF THE BLOOD.

Blood is a fluid of a rich and beautiful colour ; it is vermillion-coloured in the arteries, strong purple in the veins, and

* Page 27.

† Notwithstanding the force of this criticism, which is too valuable not to be left on record, the doctrine of the life of the blood is in my mind the best established doctrine of modern physiology. C. B.

black, or almost so, at the right side of the heart; it feels thick and unctuous betwixt the fingers, is of a slightly saline taste, is various in various parts of the body, in the heart or at the centre of the circulation different from what it is in the glands, excretories, and all the extremities of the body; different in the liver, among the intestines, in the cheeks and lips, in the reservoir or sinuses of the head and womb. In various individuals, but much more in different animals, it varies with their functions and manner of life; it is more or less perfect in animals, in birds, in fishes, in insects; it is thick or thin; has gross particles or small: is red or pale; hot or cold; according to the creature's life: and from this last variety, viz. of the manner of life, comes our division of animals into those of hot and cold blood.

It is by the most simple and natural methods that we examine the blood; since almost spontaneously it resolves itself into the CRASSAMENTUM, the SERUM and the RED GLOBULES, suspended in the crassamentum, and forming a part of it. In a cup of blood, the crassamentum or clot, the *hepar sanguineum*, as it was called long ago, floats in the serum; the red globules are engaged in this clot, and give it colour: the serum may be poured off, the coagulum may be washed till it is freed of the red parts of the blood; and then the red particles are found in the water with which the coagulum was washed, and the coagulum remains upon the strainer, little reduced in size, pure and white, the fibrine or gluten. Or we may separate this part by a method which Ruysch first taught us; we may, while the blood is congealing, stir it with a bunch of rods, when the pure and colourless fibrine gathers upon the rods, and the serum with the red particles suspended in it, remains behind.

OF THE RED GLOBULES.

The red globules, as we have observed, are not universal; yet in all creatures, even in colourless insects, there seems to be formal particles in the blood: in white insects they are white, in green insects they are green, in most insects they are transparent.

The red globules of the human blood are easily seen; they are best examined with a simple lens, the globules being diluted in serum and laid upon an inclined plane, not in water, which dissolves them quickly but in serum which has the property of preserving their globular form.—The size of the particles of the blood varies in various creatures; in the *fœtus*,

they are bigger then in a grown animal ; and though Leeuwenhoek thought is essential to his doctrine, to say, that they were alike in all creatures, we know beyond a doubt that there are in respect to the size of the animals the strangest reverses. The Skate has red globules much larger, and the Ox has globules much smaller, than those of a Man. Fish have large globules, Serpents smaller ones, and Man smaller still. In Man the diameter of each globule is much less than the three thousandth part of an inch.

There is in the effect of lenses, or in the nature of these globules, some strange refraction, by which there seems a darkness in the centre of each globule, and thence a deception which has been universal ; so that no single description has tallied with that which went before. Leeuwenhoek believed, that he saw them consisting each of six well compacted smaller globules ; Hewson believed that they were bladders, which had within them some central body, loose and moveable ; that often the central part might be seen rolling in its bag ; and that sometimes the bladder was shrunk and shrivelled around the central body, and could, by putting a drop of water upon it, be plumped up again. The Abbé Torre examined them with simple lenses too ; but they magnified so highly, that from this cause all his noisy mistake has arisen ; for he used not ground lenses but small sphericles of glass formed by dropping melted glass into water ; they magnified so much, that to him the central spot appeared much darker ; he said that these were not globules, but rings. He sent his sphericles of glass and his observations from Italy, his own country, to our Royal Society ; and for a long while, though nobody could see them, still the public were annoyed by Abbé Torre's rings. Falconer, with all the zeal of a friend, published Hewson's discoveries after he was dead ; lamenting, as we all must do, the loss of a promising young man. Falconer thought he saw these globules, not as spheres, but as flattened spheres ; he thought he saw them often as they rolled down the inclined plane upon which he placed them, turning their edges, their sides, their faces, towards the eye ; he even compared their flatness with that of a coin. Many authors have conjectured that these globules are compressed when they come into narrow passages, and expand again when they get into wider arteries. This Reichell says he has seen, and Blumenbach believes ; but Blumenbach, less easy of belief with regard to all these strange forms ascribed to the particles of the blood, pronounces his dissent in plain terms. " They appear," says he, " to my eye no other than simple globules apparently of

mucus : that lenticular or oval form which authors speak of, I have not seen."

The following are their chief properties with regard to the rest of the blood. When blood stands, they fall to the bottom, because they are heavier than the other parts of the blood ; and although the fibrine or gluten entangles them while it is forming, still it is to be noticed that the cake is always redder at the bottom ; and when by weakness or disease this coagulation is very slow, some globules escape the grasp of the coagulum, and the serum is tinged with red, and the cake, though coloured at the bottom, is white at the top, or has the buffy coat. Their form they preserve only while in the blood, and seem to be supported more by the qualities of the serum than by their own properties ; for if mixed with water, they mix easily, and totally dissolve ; the water is red, but the globules are gone ; when we mean to preserve their forms for experiment, we must keep them in serum, or must make an artificial serum by impregnating water with salts. Their quantity, in regard to the whole mass, varies so, that the appearance of the blood is a real index of health or disease ; in disease and weakness, the blood is poor and colourless ; in health and strength, it is rich and florid : by labour, red particles may be accumulated in a wonderful degree ; in hard working men they abound ; they may be accumulated by exercise into particular parts, as in the wings of Moorfowl or pigeons, and in the legs of common Hens. In short, the red globules are numerous in health ; in large and strong creatures ; and in the centre of the system, where they often circulate, when (as in fishes) all the flesh is colourless ; in such a system, particular glands only, or viscera, as the liver, stomach, or spleen, are coloured with blood, and but a small proportion circulates in the great vessels round the heart.

The redness of these particles is a peculiarity for which we know no meaning nor cause. The greatest physiologists have ascribed it to the iron of the blood ; but when we reflect how many various colours iron gives in its various states ; when we reflect, that the unknown cause which gives colour to the iron may give colour to the blood ; when we reflect, that of this crocus of iron we can hardly procure one poor grain from four hundred grains of these red particles of the blood ; we cannot but be conscious that this peculiarity is not yet explained.*

* According to Berzelius, about one fourth of the dry colouring matter is oxyde of iron.

COAGULABLE LYMPH.

The coagulable part, the cake which is felt when we wash away the red globules, that which has been called the gluten, and now by chemists the fibrine, is by far the most important part of the blood, the most universally diffused in the animal system, the most necessary for the supply and growth of parts. It forms all the solids, and in its properties resembles them most curiously ; for this cake, when washed, is white, insipid, extremely tenacious, and very fibrous ; can be drawn out greatly : and it is the coagulation of this part that makes the long fibrous strings which we find in the tub when bleeding a patient in the foot in very hot water. Being slightly dried, it shrinks into a substance like parchment ; being hardened by heat, it becomes like a piece of horn or bone : when burnt, it shrinks and crackles, with a very fetid smell, like the burning of feathers, wool, flesh, or any other animal substance ; by which we know it to be the part of the blood which is the most perfectly animalized, and the most ready to be assimilated with the living solids. When distilled, it gives ammoniacal salt and alkaline water, and a very thick heavy fetid oil, and much mephitic, which are the marks of the most perfect animal nature ; and after burning it, the residuum is a phosphate of lime, or, in other words, the earth of bones.

Its peculiar properties, as it appears in the blood, are few ; its relation to the body is very surprising.

What passes within the animal body, or how this gluten is directly applied, we never can know ; but we see how the greater part of the body is composed of gluten, and no analysis of any single part has ever disappointed us. A muscle being squeezed, and thoroughly cleansed of blood, washed in spirits of wine, and again cleaned, is seen plainly to be but a peculiar form of coagulable lymph. A bone being infused in any mineral acid, or in vinegar, its earthy parts are dissolved even to its centre ; it becomes soft and flexible, still retains the form of a bone ; but what remains consists principally of coagulable lymph. And though Fourcroy is certainly right in saying that coagulable lymph is that part upon which nature fixes irritability, or the contractile power, he should have added, "but this gluten is moreover in the animal body the basis of every part which possesses life ;" it constitutes in truth, no less than nine-tenths of the solids of the whole body. The membranes, ligaments, tendons, periosteums, and all the white parts of the animal body, consist chiefly of this. It is this fibrous part, then, which is secreted by the

vessels for repairing all the wastes, and all the accidents of the body; when a muscle is wasted by violent action, or by fevers, or by long confinement is absorbed, gluten is secreted to fill it up; when a bone is broken, much of this jelly is deposited in a bed for vessels to stretch into, and a new bone is quickly formed; when soft parts are cut, gluten is poured out betwixt them; when viscera are inflamed, pure gluten, white and membranaceous-like, is poured out betwixt them; when the uterus is to be prepared for receiving the impregnated ovum, gluten is poured out into the womb; and in all these cases it is the foundation of a union with the surrounding parts. In short, this gluten forms, nourishes, supports, restores the parts of the animal body; but far from considering it either simply, or along with the red globules, as containing the principle of life, I find it as perfect in dead vegetables as in living animals; and view it only as that particular form of matter which nature has wisely appointed for our chief nourishment and support,

THE SERUM.

The serum is the thinnest and most fluid of the parts of the blood, into which it spontaneously separates. And it contains those substances which one is almost tempted to call extraneous: this must be kept in view when its properties are to be told, for though it so exactly resembles the white of an egg, that some have, in comparing the two, written whole pamphlets on the subject, and named it the Albuminous Fluid, although it coagulates like gluten, although it putrefies like flesh, although it gives out, upon distillation, ammonia and a black and fetid oil; yet it is most natural that, along with these, it should contain also some foreign bodies, as a saccharine or extractive matter, belonging to vegetables, and some proportion of the oxalic, malic, or other vegetable acids.*

Serum is a fluid like whey, of a yellowish, or rather greenish colour, of an unctuous or slippery feeling among the fingers; it is slightly saline, and contains soda, sulphur, and phosphate of iron. It contains soda completely formed, by which it turns vegetable reds to green; it coagulates with a heat much lower than that which makes it boil; being dropped into hot water it coagulates as it falls; by 150 degrees of heat, it coagulates into an albumen like the white of an egg.

But by this influence of heat the whole does not coagulate, but only the albumen, a substance like the white of an egg;

* The lactic acid is the only free acid hitherto found in it. C. B.

what remains fluid is the serosity. On cooling, the serosity coagulates like size or jelly. This coagulation arises from the gelatin dissolved in the water : and this gelatin may be precipitated by various re-agents, but especially by tanin, and by alcohol. After the separation of the gelatin, there remains only the salts in watery solution ; these are muriate of soda, phosphate of soda, and phosphate of lime.

This analysis of the blood contains the analysis of almost all the humours or secretions of the body. Observe how nearly the urine resembles the serum : indeed the urine, like the serum, preserves the peculiar form of the red globules, and sweat is but a serum loaded with salts ; observe how little saliva differs from the serum ; observe how perfectly the serum resembles milk, since mixing serum with water produces a milky fluid, that is, a fluid which gathers cream on the top, and coagulates with acids and heat. The water of dropsies is purely serum ; the mucus of hollow passages is little else than inspissated serum ; the bile itself is said to be imitated by keeping putrid blood.* In short it is obvious that on the coagulable lymph depend all the internal secretions, (*i. e.*) for supplying the waste of the system, for enabling it to grow, for repairing bruised or cut flesh, or broken bones : that on the serum which dilutes the blood, and contains all such foreign bodies as might be injurious to the system, all the excretions, as urine, sweat, saliva, tears, &c, &c. depend.

I have said, “ that the blood is a fluid of a rich and beautiful colour ; vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart.” When we open the thorax of a living Dog, the lungs collapse, the heart soon ceases to play, the Dog languishes, expires, is revived again when we blow up its lungs :—then begins again the motion of the heart, the black blood of the right auricle is driven into the lungs : the blood goes round to the left side of the heart of a florid red ; and this purple blood of the veins, the vermilion blood of the arteries, the change happening so plainly from access of air, is a phenomenon of the most interesting nature, and binds us to look into the doctrines of chemistry for the solution of a phenomenon to which there is in all the animal economy nothing equal.

It is the study of air and aerial fluids that has brought to light all the beautiful discoveries of which modern chemistry can boast. The simplicity of the facts in chemistry, the correctness of the reasoning, the grandeur which now the whole science assumes, is very pleasing ; and makes us not without

* With the exception of the water of dropsies, all the fluids mentioned here have been found very different from serum.

hope, that by this science, all others, and ours in an especial manner, may be improved: for the action of vessels will do much in forming and changing our fluids: all the rest is chemistry alone.

The older chemists were coarse in their methods, bold in their conjectures, in theory easily satisfied with any thing which others would receive. They condescended to repeat incessantly the same unvarying process over each article of the *materia medica*: and among hundreds of medicinal plants which they had thus analysed, they could find no variety of principles, nor any other variety of parts, and names than those of phlegm, and oil, and alkali, and acid, and sulphur, and coal. By this they disburthened their consciences of all they knew, pleased their scholars, and set the physicians to work, forming magnificent theories of salts, sulphurs, and oils; for such has ever been the connexion of chemistry with physiology, that, good or bad, they have still gone hand in hand.

The older chemists thought that they had arrived at the pure elements, while they were working grossly among the grosser parts of bodies. They could know nothing of the aerial forms of bodies, for they allowed these parts to escape. When their subjects by extreme force of heat, rose upwards in the form of air, no further investigation was attempted: it was supposed that the subject of their operation was consumed annihilated, wasted into air, and quite gone. When they thus stopped at airs, they stopped where only the analysis became interesting or simple; stopping where they stopped, among their oils and sulphurs, they made their science a mere rhapsody of words. Philosophy they considered so little, as not to know that the lightest air is really a heavy body, and that with weight and substance other properties must be presumed.

Modern chemistry begins by assuring us, that these airs are often the densest bodies in the rarest forms; that airs are as material, as manifest to the senses, as fairly subject to our operations, as the dense bodies from which they are produced: that it is heat alone (a substance which irresistibly forces its way into all bodies) that converts any substance into the aerial form: that some bodies require for their fluidity merely the heat of the atmosphere, and so cannot appear on this planet in any solid form: that others require some new principle to be added, in order to give them the gaseous or aerial form: that others require very intense heat to force them into this state; but that all aerial fluids arise, or must be presumed to arise, from some solid body or basis, which solid basis is dilated by heat into an air. The solid basis of some airs can be made apparent, as of fixed air, which proceeds from charcoal; others, as

pure air, or azotic air, (the great constituents of our atmosphere,) cannot be produced to view in any solid form. But those airs which cannot be exhibited in any solid form, can yet be so combined with other bodies as to increase their weight, and give them qualities of a very peculiar nature ; and these airs can be alternately combined with a body and abstracted again, adding or abstracting from its weight and chemical properties, not only in a perceptible, but in a wonderful degree ; so that these abstractions and combinations constitute some of the most general and important facts. When the old chemists, then, neglected to examine these airs, they refrained from examining the last elements of bodies at the very moment in which they came within their power.

That these must be the most material and important facts in all the science, it is easy to explain ; for chemistry, ever since it has been a science, has rested upon one single point. There are certain great operations in chemistry which we perceive to have the strictest analogy with each other, or rather to be the same ; the operations are, the combustion of inflammable bodies, the respiration of animals, the calcination of metals ; and whatever theory explains one explains the whole. The older chemists observed, that when they burnt an inflammable body, the surrounding air was contaminated, the substance itself was annihilated, nothing remained of its former existence but the foul air ; and they supposed that this inflammable body consisted of a pure inflammable principle, which was the substance which spoiled the air, lessening its bulk, and making it unfit for supporting any longer either combustion or animal life. When an animal breathed in confined air, they found the phenomenon still the same ; the animal contaminated the air, and expired itself ; left the air unfit for burning or breathing, loaded, as they supposed, with the inflammable principle. When they calcined a metal, (which is done merely by heating the metal and exposing it to air,) they found, as in these other operations, the air contaminated, the metal losing its metallic lustre, ductility, and all the marks of a metal,—acquiring (in certain examples) new qualities, like those of some mineral acid, and becoming of course a most caustic drug ; but above all, they uniformly observed the metal to increase in weight.

To account for all these discordant changes was the most difficult part of all : it was indeed easy to say, that combustion was the giving out of an inflammable principle to the air ; and to say concerning respiration, that it was the business of the air to take away continually the superabundant phlogiston of the blood ; but how a metal should pass from a mild to a most

acrimonious and caustic state ; and above all, how by the loss of its inflammable principle it should not lose in weight, but increase in weight ! This was the Gordian knot which they had to untie, and which they cut lustily, betaking themselves, in defiance of all philosophy, to the absurd project of a principle of absolute lightness. They all agreed to call the phlogistic principle, a principle of absolute levity ; and thus their doctrine stood for many years, viz. that when phlogiston, or inflammable principle, was added to the calx of any metal, as to red lead, by roasting it with any inflammable body—the metallic lustre, tenacity, ductility, were restored, and the metal became lighter withal, because it now had within it the principle of levity. But that when by heat and air it was calcined, this principle was driven out, and then the metallic lustre, tenacity, ductility, &c. were lost by the absence of the inflammable principle upon which they all depended ; but the weight of it was encreased, for the principle of levity was gone. This is the brief abstract of the theory to which the very best chemists have addicted themselves down to the present times.

But the chief perfection of modern chemistry is, that its apparatus is so perfect that it can employ exactly a certain quantity of air in calcining a metal ; it can collect that air again to the twentieth part of a grain ; it can prove whether the metal has really been giving out any inflammable principle to the air, or whether it has received matter from the air, and how much expressly it has gained or lost. Modern chemistry proves to us, that it is not the loss of any principle that endows a metal, for example, with negative powers : but the direct acquisition of a new principle, which endows it with positive powers. Thus if you take a quantity of mercury, and expose it slowly, that is, for a long time to heat and air, the following changes take place ; it gradually loses its metallic lustre, the upper part of it assumes first a yellow and then a red colour, small red particles are seen floating on the surface of the mercury ; and these are the mercurius precipitatus per se, a most acrid calx of mercury. If, first, you estimate how much air has been expended during the process, you find that the weight of the mercury is increased in exact proportion ; if you put that calx into a gun-barrel put the gun-barrel into the fire, and by mere force of heat drive out this air, you find the quantity of air exactly equivalent to the quantity expended in the process ; you find the metal grow lighter, and recover its metallic qualities and lustre in proportion as the air is expelled. In short, we find the metal heavier when combined with air, lighter when the air is driven

out; we find it having the qualities of a metal when uncombined with air,—when combined with air having the qualities of a calx: then plainly this caustic form of the metal is not a negative quality, it is a positive one proceeding from the infusion of this new principle from the air.

By such proofs as these chemistry has explained, in a most philosophical way, how all these phlogistic processes, as they were called, depend, not on the abstraction of phlogiston, but on the addition of a new principle; that they all arise from one positive power, that the same principle gives life to fuel, increase of weight (and other effects of calcination) to metals, acidity to acids, and redness to the blood. These are all performed by one power; they are all essentially one process; their are all effected by the communication of one sole principle, viz. the basis of pure air.

Upon our atmosphere and its surprising harmony with all parts of nature; with animal and vegetable life; with water, metal, acids, and all the solid bodies into which it enters—much more depends than it is easy to conceive. Could we have supposed that it was the cause, not merely of life in all living creatures, but almost the cause of all the properties that reside in the most solid forms? Could we have supposed that the air rendered heavy bodies heavier, changed metals into the most caustic substances, converted many bodies into acids, changed inflammable air into the pure element of water, which at least we have hitherto conceived to be pure? Yet if there be one word of truth in chemistry, all this is true.

The atmosphere contains various gases or airs; but one only, viz. vital air or oxygene gas, is useful to respiration, combustion, and animal life; that purer air must, like every other, arise from some solid basis: that basis cannot be shown in any substantial form, but it can be combined with many various bodies, so as to give them an increased weight and new qualities; and thence we presume to say, whenever we see a body by such a process, acquiring such qualities, that it acquires them by absorbing the basis of pure air; for pure air is nothing but this presumed basis dilated into the form of air by heat; and when it combines with any body, it gives out its heat; so that in all these processes heat is produced. And although inflammable bodies, metals, acids, and animal blood, seem very distinct from each other; although combustion, breathing, calcination, and the forming of acids, are processes seemingly very unlike; yet they are all in their essential points the same, viz. a change of qualities and a production of heat in consequence of the absorption of pure air.

First, when an inflammable body is BURNT or consumed by fire, the basis of pure air is combining with the combustible body; the air is entering into a new combination, and therefore must give out its heat; it combines rapidly, gives out its heat rapidly, is wasted; the inflammable body burns and seems to be consumed; but if we catch that air which escapes from the inflammable body, we find it to be equal exactly to the whole weight of the air and of the burning body that have been consumed; and this air consists of two parts, viz. of the substance that was burnt, and of the basis of pure air. Thus, for example, when we burn charcoal or carbon, the whole substance of it, weight for weight, is converted into an air, which is called fixed or carbonic acid gas; the same which is discharged from stoves, the same also which is found in pits, the same which oozes through the ground in the Grotto del Cane, the same which floats upon the surface of fermenting vats, and which is so much heavier than common air that it can be taken out from a vat in basins, and poured from dish to dish. Combustion, than, in a process which consists in the rapid assumption of the basis of pure air, and a consequent conversion of the burning body into an air or gas endowed with peculiar qualities and powers.

If, then, the oxygenation of the blood be a process like this, it must differ chiefly in degree; it might in certain circumstances become too rapid, and resemble an actual combustion; and so in certain circumstances it does, for our atmosphere is so tempered that no more than 27 parts out of 100 consist of pure air;* the rest is food for vegetables, but not fit to maintain flame or animal life. This is the reason that even burning as well as breathing are slow processes, and that an animal, if made to breathe pure air or vital air as it is called, gets oxygene too rapidly supplied, is consumed and inflamed quickly, and dies.

Secondly the process of CALCINATION is the same in all metals; it also is an assumption of the pure air, or rather of its basis, with a change of qualities and increase of weight: if you calcine lead slowly, it becomes first yellow, then orange, then red; it becomes heavier, so that from 100 pounds of lead you have 110 pounds of lytharge, or calx of lead; if you calcine mercury, it also becomes first yellow, then red, and much heavier than at first: if you distil any of these metals, you can by heat merely drive out the purest air from them; they recover their brilliancy, and grow lighter, because the basis of air is expelled. The basis of pure air is expelled, not in that solid form in which it was embodied by the calx, but being

*Twenty one by weight of oxygene.

now combined with heat, it appears in the form of vital air; the air is much purer than that of the atmosphere which was used in the process, because the metal absorbs or appropriates to itself nothing but the purest air, leaving the azotic or foul air behind; and finally, if you wish to see the harmony betwixt combustion and calcination, or to be assured that calcination is truly the burning of a metal, take some of this pure air, which is three times purer than the atmosphere, and raises an intenser flame; plunge into it a piece of iron wire, which is made red hot; and this wire (which would only have wasted or rusted into a calx in the common atmosphere) will in the pure air burst out into a brilliant white flame, and burn entirely while it has such air; nay, some metals, as zinc, burn even in our common atmosphere with a most brilliant flame.

From this second process, must it not be presumed that the principle which gives an increase of weight and such singular properties to various metals, must have very interesting effects upon the blood.

Thirdly, it is from this principle also that all acids are formed; and as oxyd is the Greek name for acid, the great Lavoisier has thought fit to give a name to the basis of air, or that principle which is obvious only when operating in such processes as these. He adds to the Greek name for acid that verb which implies the generation of any substance; he calls it thus oxygene, or the principle which generates acids. It were easy to show how truly this great point is supported by all the particular operations in chemistry; it shall be sufficient to observe a few.* When we burn sulphur in open air, it seems to be consumed; but when we burn it in close vessels, still giving a free access to air, we find it converted into an acid the most pondrous of all, weighing greatly more than the sulphur from which it was procured. The operation is done in close vessels: nothing can pass but what is known, and nothing is more certain than that the whole of this wonderful and rapid change is the mere effect of the sulphur, which is an acidifiable base, assuming the acidifying principle by which alone it can become an acid. Phosphorus being burnt in a close glass upon the point of a wire, the vital part of the atmosphere is consumed, the azotic air (which the ancients mistook for their phlogiston) remains, the whole phosphorus is changed into phosphoric acid, and the whole acid, when weighed, expressly equals the phosphorus which was burnt, and the air which was consumed along with it. Nay, arsenic, which is a metal, being calcined, is converted into a perfect acid. Thus we see, first, that calcination

* To this doctrine numerous objections occur:—oxygene by union with hydrogen forms water; sulphur by union with hydrogen forms sulphuretted hydrogen, an acid, &c. &c.

is a mere combustion, since it can be made so rapid as to be attended with heat and flame; next we see that acidification is, like calcination, attended with heat and flame, and an acquisition of weight and of properties like those of calces. We see some metals converted into proper acids; acids and metals mixing in qualities with each other; acids and metals are both acidifiable basis, both are capable of receiving new and similar properties, by assuming into their composition the basis of pure air; and in one single process the whole set of phenomena are exemplified, for in burning arsenic we have combustion, calcination, and generation of acid, all in one process, the product being named indifferently oxyd of arsenic, or white calx of arsenic.*

But if most acidifiable bases be thus forced by combination to forsake their solid and assume their aerial form, others more singular still are recalled from their aerial form, and condensed into the fluid form of a strong acid. Thus azotic or nitrogenous air, which forms the great bulk of our atmosphere, is converted by oxygenous or pure air into an acid form; † it becomes nitrous acid, nitric acid, nitrous air, strong or weak according to the various degrees of oxygenation communicated to it; and thus nitrous air, by its appetite for oxygene, and by its change of colour and its condensation, whenever it takes oxygene from the air, makes an eudiometer or measure for the purity of the air; and, according to the purity of the atmosphere, more turbidness and more redness is produced in the nitrous air, and greater loss of bulk, which may be marked on a scale.

The oxydation of the blood makes a fact no less important in physiology than those are in chemistry; for as there are various marks of the influence of oxygene on the blood itself, there are terrible proofs of its importance in the system, and how miserable the person is who has imperfect organs, or an ill oxygenated blood.‡

Nature, disregarding all occasional supplies, as by the absorption of the skin, the assimilation of aliments, &c. has appointed one great organ for the oxygenation of the blood, viz. the lungs. In opening the breast of a living creature we best see the connexion of respiration with the great system; but

* It is necessary to add nitre to make it burn. The result is not directly an acid, but a neutral salt formed of the arsenical acid joined to the alkali of nitre; without the help of nitrous acid it is only an oxyd or imperfect acid; and is necessary to use the hyper-oxygenated muriatic acid for communicating to it a sufficiency of oxygene to constitute it a perfect acid.

† *N. B.* It is necessary to enclose them in one vessel, and to pass the electric spark through them that they may unite.

‡ Yet I must here again observe that there are no decided proofs the oxydation of the blood. C. B.

it is out of the body that we can best understand its particular effects upon the BLOOD.

The most obvious effect of air is its heightening the colour of the blood. If we expose blood to fixed air, or azotic air, it continues dark; these fluids communicate nothing, they have no effect on the colour of the blood: when we expose blood to atmospheric air, it assumes a florid colour, for in the atmosphere there is a large proportion of oxygene gas: if, lastly, we expose it to oxygene gas, the purest of all air, it grows extremely florid; and whenever it changes its colour, it is by absorbing oxygene, for it reduces in the same proportion the quantity of air; what it absorbs is the oxygene or pure air, what it leaves is mephitic, unfit for combustion or animal life.”*

Blood when exposed to the air becomes red chiefly on the surface, it remains black beneath, but by turning up the clot to the air all the surfaces become red. If air be blown into a tied vein, the blood which was black in the vein becomes florid; and when the air is pressed out again, it becomes black. If the air-pump be exhausted over a dish of blood, the blood becomes dark in the vacuum; and it becomes florid when the air is allowed to rush in again. If you expose blood in a moist bladder, the blood is oxygenated through the walls of the bladder; which brings this experiment as close as may be to the phenomenon of blood oxygenated, through the walls of the lungs. Though serum or milk be interposed, or urine, still the blood is oxygenated, because these are perfect animal fluids; but it is not oxygenated, if oil, mucilage, or mere water, be interposed.

When we open a Frog, or Newt,† or other amphibious creature, we see a long and slender artery accompanied by a slender vein, running from top to bottom along the whole surface of their lungs; and while their heart continues to beat, we see this pulmonic artery black, the vein red, the lungs themselves most delicate and pellucid, like the swimming bladder of a fish: even in the extremities of the human system the blood of a vein is dark, of an artery red; so that surgeons distinguish venous and arterial hæmorrhagies in this way.

From these facts we may understand why the blood of the womb, of sinuses, of varices, and of all stagnant veins, is so offensive and black; and why that blood is so very pure and florid which is coughed up from the lungs. Is not the face livid in apoplexies or strangulations, in hanging or drowning, in fits of passion or of coughing, or in any accident which interrupts the lungs? The face of a child during a paroxysm of

* Carbonic acid gas is formed; the absorption of pure oxygene is doubtful.

† See Chap. III.

the whooping cough, is it not completely black? Is not the hand livid when the arm is compressed or tied up, and its blood prevented from returning to the lungs and heart? Are not tumours dark coloured from dilated veins which return their blood too slowly? Are not these mulberry marks which are born with us just small aneurisms full of ill oxygenated blood? Then this first effect of oxygenation is a reddening of the blood. The menstrual blood, the blood of ecchymosis, (as in those who have been whipt,) the blood of aneurismal bags, are all black; and the blood of varices is so very black, that the ancients said they were filled with atrabilis or black bile. The stripes inflicted on a soldier as a punishment are at first of the most lively red, but soon become black.

The next effect of oxygenation is the endowing the blood with a peculiar power, by which it is continually operating upon the living solid: this is a power which it is continually losing; which it is every moment giving up to the solids; and which no other process but respiration can restore. This stimulant power the blood gradually loses as it circulates round the body; it is quite effete when it returns to the right side of the heart: the heart of a creature never moves, if we allow its lungs to lie collapsed; but the heart returns to act the very instant that pure air is forced into the lungs, and so communicated to the blood. This stimulant power is most of all apparent when we force a living creature to breathe nothing but the purest air; for oxygenated or vital air makes this process too rapid; the pulse rises, the eyes become red and prominent, the creature seems drunk with the new stimulus, too great for its system. The universal heat of its body is greatly increased, the eyes are turgid and red, and at last a sweat breaks forth all over it; and when dead, the lungs (it is said) are mortified or inflamed. But whatever the marks are, whether these signs of inflammation be really true, it is plain, since the creature dies, that pure air is fatal by a too rapid oxygenation of the blood. If, in our experiments upon a dying animal, we inflate the lungs with mephitic air, the heart does not act; if we inflate its lungs with common air, the heart begins to act; if we inflate its lungs with oxygene air, the heart is irritated to a still more powerful action.

If we open the breast of a Frog and stop its breathing, we observe, first, its pulmonic blood florid, and the heart beating strongly: secondly, in half an hour the pulmonic blood has become dark, and the heart's motion has grown languid; in a little while the pulmonic blood becomes black, and the pulsation of the heart ceases: and, lastly, the trachea of the Frog

being united, and the creature allowed to breathe again, the blood becomes florid, and the heart acts.

OF THE HEAT OF THE BLOOD.

The next effect of oxygene is said to be the communicating of HEAT to the lungs. But I suspect that if the small quantity of oxygene which can enter by the lungs do communicate heat, it must be not to the lungs; nor to the blood, but to the whole body through the medium of the blood. There are some who pretend to say, that when they draw in vital air, they feel a genial warmth in the breast, diffusing itself over all the body; but it is easy to feel in this way, or any way, when a favourite doctrine is at stake, while those who know nothing about doctrines, breathe the vital air without any peculiar feeling which they can explain.

There are many circumstances which make it hard to believe that there is in consequence of the oxydation of the blood, any remarkable generation of heat in the lungs. Oxydation of the blood, out of the body, is attended with no increase of heat, and yet we operate on a quantity of blood much greater than that which circulates through the lungs.

To suppose, but for a moment, that all the heat which warms the whole body emanates from the lungs, were a gross error in philosophy: it were to suppose an accumulation of heat in the lungs equal to this vast effect of heating the whole body. But were it so, we should feel a burning heat in the centre, a mortal coldness at the extremities, and marked differences in the heat of each part in proportion to its distance from the lungs. In fevers, we should feel only the intense heat of the centre; we should be distressed, not with the heat in the soles of the feet or palms of the hands, or in the mouth and tongue; we should feel only the heat of the lungs. When the limbs alone were cold, would the lungs warm them? How could it warm them up to the right temperature without overheating the whole body? When a part were inflamed, how could the heat go from the lungs, particularly to that point, and rest there.

From the lungs the heat could not be regularly diffused; for in almost all the Amphibiæ the lungs are far distant from the centre of the body, and could not communicate any degree of heat to the extremities without the greatest waste; they would, according to this theory, have lungs for crying with, if they pleased to cry, but by no means for distributing heat.

But in reflecting upon this most difficult of all subjects, the

generation of heat in the living body, many things are to be taken into the calculation, which seem, on the slightest glance, to be far more important than this disposition of oxygene from the blood. It is a law of nature, to which, as far as we know, no exception is found, that the body, while it passes from an aerial to a fluid form, or from a fluid to a solid form, gives out heat. Now, what is the whole business of the living system but a continual assimilation of new parts, making them continually pass from a fluid into a solid form? The whole nourishment of the body goes on in the extreme vessels, and is a continual assumption of new parts. The extreme vessels are continually employed in forming some acids, which appear naked in the secretions; in forming oxyds, as the fat and the jellies of the membranous and white parts: in the various depositions of muscle, bone, tendon, &c. for these are all continually absorbed, thrown off by the urine, and incessantly renewed. They are continually employed in filling all the interstices of the body with a bland fluid or halitus; they are continually employed in forming secretions of various kinds. In performing all this the power of the vessels may do much; but the ultimate effect in each process must be a chemical change, and perpetual changes will produce a constant heat, Place the organ and focus of this animal heat in the centre of the body, and you are embarrassed in a thousand difficulties; allow this heat to arise in each part according to its degree of action, and each part provides for itself.

But how then, some will say, shall this heat be regulated? I say plainly by the heart and lungs. The lungs regulate the stimulant power of the blood, the heart regulates the action of the arteries, in so far as regards the stimulus of fulness and distention; and with these to regulate the centre, nothing can alter the heat of the extremities except partial actions that is, disease.

I will conclude then, that oxygene, if it do communicate heat, does so, "not to the lungs, nor to the blood, but to the whole body through the medium of the blood."

OF THE RESPIRATION OF ANIMALS.

The effects of oxydation then are, to redden the blood, to renew its stimulant power, and to communicate heat, not so much to the blood, as to the whole body through the medium of the blood, and to assist in the secretions and chemical changes which are incessantly going on in all parts of the system. This is accomplished by the perpetual and rapid

motion of the blood through the lungs ; and there it is exposed to our atmosphere, which is a mixed fluid very different from what we at first conceive, or what our ignorant wishes might desire to have it ; not consisting merely of air fit to be breathed, but for the greatest part formed of an air which is most fatal to animal life, whence it has the name of Azotic Gas. Of a hundred measures of atmospheric air, we find twenty-seven only to consist of vital or pure air, that is oxygene ; seventy-two consist of azotic air, or nitrogene, as it is called, fatal to animal life ; and one measure only is fixed air, or carbonic acid, which is also an unrespirable air. But of these twenty-seven parts of pure air, seventeen parts only are affected by respiration ; so that in respiration we use much less than a fifth part, even of the small quantity of air which we take in at each breath.

The change of the air by respiration is this chiefly ; that the quantity is diminished by the abstraction of a part of the oxygene ; that there is formed a quantity of carbonic acid gas by the union of the carbon of the blood with the oxygene respired ; and that there is discharged along with these a quantity of water halitus. Therefore atmospheric air, after it has been breathed, is found to have suffered these changes : First, It contains now a considerable proportion of carbonic acid, which is easily discovered, and even weighed ; because when a caustic alkali is exposed to it, the alkali absorbs the fixed air and becomes mild. Secondly, It has less of the vital air, as is easily ascertained by the eudiometer which measures the purity of the whole : And, thirdly, All that remains is merely azotic air, unfit for animal life, or for supporting flame. The oxygene, then, in part unites itself with the blood : in part it forms fixed air by combining with the carbon of the lungs ; in part it forms water by combining with the hydrogen of the blood. Respiration frees the blood of two noxious principles the hydrogen and carbon ; and it insinuates a new principle, viz the oxygene, into the blood.*

* Such has been the opinion of chemists up almost to the present day ; but the rapid changes of opinion, and indeed of whole systems, and the confusion into which the discoveries of to-day throws the result of all preceding labours, would almost provoke an anatomist to put out of his system the chemical discussion altogether, until the masters of that science have better arranged their materials, and have arrived at acknowledged principles. More careful experiments have proved that the volume of air expired is the same with that inspired,—the respired air differing only in the variable proportion of carbonic acid gas, and aqueous vapour ; that all the oxygene taken from the atmosphere by respiration, is consumed in the formation of the carbonic acid gas found in the respired air ; and that the heat evolved by respiration is not the heat of the body, but the heat of the air respired, latent before, and now become sensible, owing to a change of capacity in the gases.

The change produced in the blood during the circulation in the lungs, is simply

Nature has appointed but a small proportion of vital air for our use; our atmosphere is so constituted as to hold but a fourth part of vital air, and of that small proportion one half only is used in the lungs. We see by this how necessary this contamination of our atmosphere is which seems so unfavourable to life; nature intended that we should breathe slowly a modified atmosphere! With nothing but the purest air to breathe, our life would be quickly consumed, like that deflagration of iron, which is so rapid in vital air, while it burns so moderately and slowly in the common air.

These assistances which we have from chemistry are but a promise of what that science may do; nothing of all that we know concerning the chemistry of the blood is either perfect or sure: we have our expectations still of seeing things more completely explained: but our expectations are not like those of Mr. Moises, who, in a certain dissertation on the blood, seems so full of his new lessons in chemistry, and so confident of his future achievements in that science, as to expect that muscular motion shall be very thoroughly explained, and that it will be found to be nothing else, in all the world, but "an explosion of hydrogen and oxygen," and God knows what! but it is after the manner of "a steam engine;" and if his scheme holds, they are to be fired off "by means of the nervous electricity of Galvani!"*

OF THE MEMBRANES OF CAVITIES, AND PARTICULARLY OF THE MEMBRANES OF THE THORAX.†

Every part of an animal body, with the exception of the fluids, the matter of the nerves, of the muscles, and of the

to free it of the superabundance of carbon with which it is loaded in consequence of the secretions performed in the extreme vessels of the system of the body.

As to the heat of the body, chemists seem to have agreed, that full confidence is to be put in the experiments and opinions of Dr. Crauford, whose theories have been criticised in former editions of this work. The brief abstract of which doctrine is this. The venous blood has less capacity for retaining heat than arterial blood. When the blood of the arteries of the body is converted into purple blood, and enters the small veins, heat is let loose and becomes sensible, giving warmth and a stimulus to the operations of the animal economy. When this venous blood is, in the round of the circulation, brought back to the lungs, while it throws out its superabundant carbon and when this carbon unites with oxygen of the air respired, and forms carbonic acid, heat is evolved. While this action of respiration is producing heat, it is also forming of venous blood arterial blood. And as the arterial blood, in its conversion into venous blood, gave out heat, so now, being reconverted into arterial blood, it takes up heat, and that is not sensible heat, but latent. There is, therefore, no central fire, as it were, in the breast, and yet there is a source of heat to the whole body from the operation of the lungs. And what degree of heat more than necessary for the conversion of the blood, and which might be injurious, is expended in forming the vapour exhaled from the lungs. C. B

* Vide page 236.

† By Charles Bell.

bones, is resolvable into membrane by masceration and the contrivances of the anatomist. The fine web which supports the retina in the eye, and the strong cord on which the gastrocnemius acts, are formed of the same kind of tissue, the cellular texture. Another remarkable circumstance is, that this cellular texture no where terminates, or that the membranes of the body are every where in continuity. If, for example, we begin our investigation with the tendon of a muscle, we shall find that it is resolvable into a twisted membrane, we may trace this membrane into the muscle, and we shall find it enveloping the muscular fibres, and extending through the muscle, and uniting again to form the tendinous insertion of the muscle into the bone. From the tendon the continuation is direct to the periosteum; the periosteum is continued into the ligaments and capsule of the joint; from this again we may trace the fascia, and intermuscular septa. These firmer structures we shall find loosening into the common cellular texture, and that texture, as has been already explained, may be traced over the whole animal frame.

But we have now particularly to consider the structure and connexions of the membranes of the great cavities of the body; and, in the first place, the membranes of the thorax.

A membrane is an expansion or web of animal matter, having extension with a scarcely measureable thickness: it has one surface, free or disuniting, and smooth, and lubricated with a secreting fluid. It has the other surface rough and attached, being more like the common cellular texture, of which, in fact, the whole membrane is a composition.

The membranes of the viscera are arranged in two grand divisions, viz. the mucous membranes, and the serous membranes; all of which are remarkable for their extent of surface, but especially the former. The difference of the two great classes of membranes is referable to the nature of their secretions. The object of the secretions is to prevent adhesion of contiguous surfaces, which is most effectually done by the mucous secretion. But as the mucous secretion is not readily soluble nor prepared for absorption; as when secreted it must be thrown off from the surface, and urged out of the body altogether; it is obvious that this is a secretion calculated solely for the membranes which are open, and from which it may be discharged.

The serous fluid is finer, more watery, and very readily absorbed; so that it is supplied to moisten the surfaces of shut sacs, and membranes which are continuous and have no outlet, such as those lining the great cavities. But if there be

any tendency to inflammation on these surfaces, they are more prone to adhesion than the mucous membranes, because the inflammatory action will more quickly convert serum to coagulable lymph (which is the medium of adhesion) than it will the mucous secretion.

The mucous membrane is the continuation of the skin; it is every where continuous, but it admits of a natural division, viz. 1. The mucous lining of the lungs; 2. The mucous lining of the alimentary canal, and the ducts which open into it; and, 3. The mucous lining of the urinary organs.

We may trace the first from the nostrils up into the cavities of the nose, and from that into the lining membrane of the cells of the face. We may then trace it backwards into the throat, into the larynx, the trachea, the bronchi, and finally, into the bronchial cells, an extent perhaps equal to the whole surface of the body.

To trace these continuous surfaces is not an idle minuteness; for we require to know, that inflammation will creep along the surface by a prevailing action, which has got the name of continuous sympathy. Thus we are sensible in catarrh of a sense of pain and weight in the forehead, commencing with a dryness of the cavities of the nose; then we have increase of secretion, and tickling in the larynx; this is followed by pain and a sense of rawness in the throat; lastly, we have pain in the chest, or an uneasy tickling sensation in the very margin of the lungs, and thus the inflammatory action terminates only with the extremity of this long line of connexion.

The second division of the mucous membrane is the lining membrane of the mouth, which we trace into the œsophagus, into the stomach, into the intestines; and, after a course of full seven times the length of the body, it appears on the verge of the anus, terminating, as it began, in the skin; and along the whole of this mucous lining we may sometimes trace the course of inflammatory action. An erysipelatous blush, visible in the throat, will sometimes take its course in a very dangerous manner, over the whole extent of the canal, even to the anus.

The third division of this membrane is where the fore-skin is reflected over the extremity of the penis into the urethra; here the mucous secretion commences, and it characterizes the whole extent of the canal, tracing it through the bladder to the pelvis of the kidneys.

Thus we shall find, that the mucous membranes form the internal surface of all the hollow viscera, and now we shall also see that the serous membranes form all the outward sur-

face of the same viscera. The course of the serous membranes are, however, by no means so simple nor so easily comprehended by the student as that of the mucous membrane. I shall at present confine myself to the anatomy of the membranes of the thorax or chest.

OF THE PLEURA.

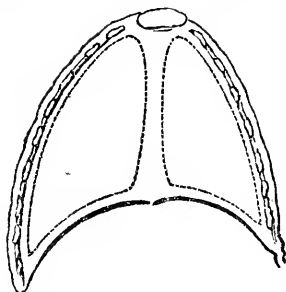
The thorax is the superior cavity of the trunk, and contains the heart and great vessels, the lungs, and the thymus gland : it transmits into the abdomen the œsophagus and nerves ; and these parts are involved and supported by the processes of the pleura.

The pleura is the fine serous membrane which lines the two cavities of the chest, and is reflected upon the lungs. We shall consider it first as it lines the ribs (and where it is called *PLEURA COSTALIS*;) 2. then as it is reflected on the diaphragm ; 3. as it forms the septum dividing the chest ; 4. as it is reflected to cover the lungs (where it is the *PLEURA PULMONALIS*.)

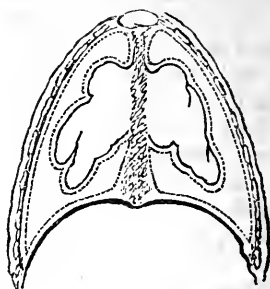
The *PLEURA COSTALIS* is the lining of the walls of the chest. These walls consist of the ribs, their cartilages, and the sternum, their interstices being filled up with the intercostal muscles. The lining membrane of course is attached in part to the inside of the ribs, in part to the muscular texture which intervenes. It is a simple membrane ; for so we call it, although like every other membrane it may be divided into layers of cellular membrane. On its outer surface it is most loose and cellular in its texture ; on the surface towards the cavity it is smooth and bedewed with secretion, and is consequently unattached. The pleura lining the ribs is very thin, and is immediately attached to the periosteum.

As the ribs and sternum form the walls of the chest on the lateral and foreparts, the diaphragm forms the floor of division betwixt the cavity, of the chest and the lower cavity, the abdomen. From the ribs, the membrane is reflected upon the diaphragm, to which it adheres ; and from the diaphragm and lateral parts of the chest, it is reflected to form the division of the chest, which is called mediastinum ; which completes the circle of connexions, as far as relates to the lateral cavity of the chest.

PLAN 1.



PLAN 2.



In the first plan here, the dotted line represents the course of the pleura, in a supposed section of the chest. Two lateral cavities are seen with a partition; that partition or septum is the mediastinum, and passes from the spine to the sternum, dividing the chest into two lateral cavities. The second plan shows the manner in which the pleura is reflected to cover the lungs and form the pleura pulmonalis: a dotted line still marks the course of the membrane; and here we may observe, that when the pleura has formed the septum, called mediastinum, it is there again reflected over the vessels going to the lungs, and covering the vessels protects them, and forms what is called the ligament of the lungs. Tracing the membrane in its course, we do not find that it terminates any where; we find that it is every where continuous, and that the pleura pulmonalis and pleura costalis are the same continued surface of membrane.

But in these plans a liberty is taken to represent the lungs shrunk, and leaving the sides of the chest, a thing which never takes place in nature. This is done that my reader may follow the line distinctly; properly the surface of the lungs, (that is the pleura pulmonalis,) and the inner surface of the ribs, (the pleura costalis,) should have been in contact; for although we continually speak of the cavity of the chest, yet there is no cavity but in disease, or when by wounds the air is permitted to escape from the lungs, and then, indeed, the circumstances are as represented in this plan; for the lungs leaving the side of the chest, there is a cavity which is then filled with air.

The 1st *Plan* shows the two cavities of the thorax formed by the pleura costalis, and the septum or mediastinum formed by the meeting of the membranes.

The 2d *Plan* shows, by the continuation of the dotted line, how the pleura costalis is continued into the pleura pulmonalis.

When we trace the membrane of the ribs over the lungs, we comprehend how the smooth and proper surface of the one is internal, and the other external ; and yet that these surfaces are continuous and the same. We understand too how the surface of the pleura pulmonalis and costalis are in close contact, and yet do not adhere, and that consequently freedom is given to the motion of the lungs. At least, if in respiration the lungs do not move from the sides of the chest, they are not prevented by the adhesion of the pleura when in a healthy and natural state ; but by a circumstance already in part explained. The lungs cannot recede from the pleura covering the ribs, because no air can be admitted to fill the space which would be then necessarily formed betwixt the lungs and ribs.

The **LIGAMENTS** of the lungs are understood when my reader comprehends the manner in which the pleura is reflected from the ribs over the spine, and from the spine over the great vessels and over the lungs. Where this reflection of the pleura takes place, embracing the tubes and vessels going to the substance of the lungs, it forms ligamentous roots, the only natural connexion of the lungs to the chest.

The **MEDIASTINUM** is a partition dividing the great cavity of the chest into two lateral parts : it is stretched from spine to sternum. This is a common, and it may be a true description of the mediastinum as far as it goes, yet it is a most imperfect one. This partition of the thorax is esteemed a provision for our safety, worthy of all admiration ; and so indeed it is. But when it is said that this partition provides that a man, being diseased in the lungs of one side, or wounded betwixt the ribs of one side, may still breathe with the other, I would venture to say, that it is a wrong reading in that volume which it ought to be our pride to preserve pure. Every motion of the natural system has its proper check ; every delicate part has its guard against the violent motions of the natural system : and is constituted with a due provision against the injuries we are liable to in a state of nature. But nature had it not in contemplation that we should be exposed to the gun and bayonet, nor can I think with a celebrated anatomist that she has provided for sustaining the prolonged existence of him who is slowly wasted by pulmonary consumption. I cannot believe that there is either in the foramina of the heart, or the mechanism of the chest, a provision against the effects of disease. I have therefore to show that the mediastinum has a reference to the support of the heart and great vessels, against the unequal pressure to which, without this guard they would be exposed in the necessary and natural changes to

which the body is subject in health. But I have said that the description of the mediastinum is imperfect; and really, though seemingly simple, it is difficult to represent by words the connexion of the membranes of the thorax.

The two distinct sacs of the pleura, each forming a lining membrane to the two sides of the thorax, approach towards the centre of the cavity, and would absolutely unite but for the intervention of the heart and its appendages. And so indeed it is, that anterior and posterior to it, these membranes nearly touch. Where the sacs of the pleura approach each other anterior to the heart, they form the *ANTERIUM MEDIASTINUM*; and in the same manner behind the heart and near the spine, they form the *POSTERIOR MEDIASTINUM*.

The anterior, or pectoral mediastinum, has, in the embrace of the membranes, much cellular membrane; and when in dissection we raise the sternum, this loose cellular membrane allows the pleura to be drawn separate so as to form a cavity, which cavity did not previously exist. The anterior mediastinum contains the thymus gland, some absorbent glands, a considerable trunk of the lymphatic system, which has been called the *DUCTUS THORACICUS ANTICUS*.

The posterior mediastinum, called sometimes *DORSALE*, contains the extremity of the trachea and part of its branches called bronchi, and part of the pulmonic artery and veins; the œsophagus, for the greater extent of its course, the descending aorta, and the great trunk of the absorbents, the thoracic duct, the eighth pair of nerves, and the dorsal lymphatic glands.

Both the mediastina are a little towards the left side, and the posterior one is much the longest.

I now leave authority, and proceed to describe the more important connexions of the membranes of the chest with the heart and great vessels. The pleura, which is a very thin and weak membrane where it invests the lungs or adheres to the inside of the ribs, is particularly strong where it is reflected from the diaphragm. And from the diaphragm to the upper and more contracted part of the chest, all along the tract of the cava, it is of a ligamentous firmness, and is more like a fascia or tendon than those layers of cellular tissue, which have of late got the name in connexion with the subject of hernia. Towards the upper part of the chest, the pleura, or rather the mediastinum, covers and embraces the branches of the cava, and posteriorly it covers and protects the aorta and thoracic duct; in short were it not the fear of confounding the ideas of the younger student, I would say, that this structure of membranes excludes all but the lungs from the cavity of the chest; and consequently from the effect of the chest's

motion in respiration. How the respiration does not affect the veins and cavities of the heart, will now, I trust, be easily conceived, and consequently the use of the mediastinum be understood.

But before I proceed further, I must here observe that the pleura, where it is reflected to form the mediastinum, is double; that is, the cellular texture acquires a different structure, has a ligamentous firmness, and performs the office of a fascia around the vessels, an office which could not have been done by the mere reflection of the lining membrane of the chest.

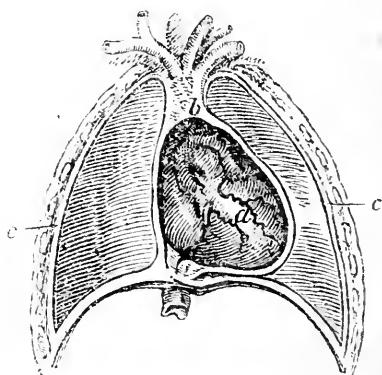
The enlarged capacity of the thorax in every direction, the raising of the ribs, the thrusting out of the sternum, is attended with the contraction and sinking the arch of the diaphragm. But this motion which expands the cells of the lungs, and draws the air into them, would disorder the heart's motion, would cause a lodgement of the blood and distention of the great veins and sinues, were they under the influence of the motion of respiration. But the diaphragm moves only on its lateral parts, or it is checked and intercepted at the middle part by the connexions of the mediastinum. In proportion as the lateral cavities of the chest and the lungs consequently suffer the influence of this expansion of the chest, and have the pressure taken from them, (which bore against the weight of the atmosphere,) the parts contained in the mediastinum suffer pressure by the action of the diaphragm and rising of the sternum. If the veins near the heart were exposed to the same influence that the lungs are, they would be subject to the same change of quantity of what they contain; the blood would be accumulated in inspiration, and forced out from them in expiration, and the regular action of the heart interrupted or disturbed.

There is a further use in these connexions of the membranes surrounding the great vessels with the diaphragm, viz. to preserve an equilibrium or equal pressure upon the great vessels of the trunk during the violent action of the muscles. Thus in leaping, pulling, or straining, in any way, there is a sudden and great pressure on the viscera and veins of the abdomen, and at the same time there is a powerful acceleration of the blood from every remote part towards the great veins and right sinus of the heart. These vessels would be overpowered and burst but for the protection of the mediastinum, and the support which the diaphragm gives by its connexion with the mediastinum, and by acting in opposition to the abdominal muscles.

OF THE PERICARDIUM.

The pericardium, or heart purse, is the third cavity of the thorax; but here again I must caution my readers on the use of the term cavity. The pericardium closely embraces the heart, retains the lubricating fluid, and restrains and limits the heart's motion. But this being already explained, I have only to add a circumstance not noticed under the former head. The pericardium is a double membrane: the inner layer of membrane belongs to the class of serous membranes; the outer is quite of a different character, being a tissue of strong fibres which form a web as strong as a fascia. It is this external layer of the pericardium which is continued upon the great vessels as they arise from the heart, and which forms their supporting sheath; and what the closer texture of the sheath does to restrain and support the arteries and veins, is done by this outward layer of the pericardium to the heart.

The next point left unexplained is the manner in which the heart and pericardium are embraced by the pleura.



In this plan we see how the heart, surrounded by the pericardium, is further embraced by the mediastinum, by which it is not only supported, but the great vessels are surrounded and led securely out of the thorax, until they reach their proper sheaths in ascending upon the neck or passing out into the axilla.

a The heart. *b* the pericardium. *cc* the pleura of the right and of the left side. embracing the pericardium betwixt them.

OF THE THYMUS GLAND.

The thymus is a gland of a pale colour and soft consistence, having many divisions or lobuli. It lies immersed in the cellular membrane of the anterior mediastinum, but stretches upwards on the neck, and its extremities are betwixt the trachea and carotid arteries, but it lies principally on the pericardium. It has two superior cornua, and two inferior, the right of which is the longest. On puncturing this gland a white fluid may be expressed, and when we blow into this puncture the air pervades the whole gland, giving the appearance of a cellular texture; but no ducts have been discovered. The thymus occupies a very considerable space in the chest of the fœtus, while it diminishes rapidly during childhood; therefore it is presumed, that it has a function adapted to some peculiarity of the fœtal circulation: but not even a probable conjecture has been offered further. It has been supposed a kind of diverticulum chyli. It has been supposed to secrete a fluid to attenuate the blood; it has been supposed to separate a peculiar fluid which was again thrown into the blood through the small veins. It has been supposed useful to fill up the thorax during the contracted state of the lungs in the fœtus; forgetting altogether that it is large in the fœtus and diminishes after birth, it has been supposed to protect the lungs from the pressure of the sternum; all which are suppositions merely, that have not the most distant proof to support them, and yet possess not sufficient absurdity to make them worthy to be recollected on that account.

OF THE LUNGS.

THE LUNGS are the soft compressible bodies which fill the two lateral cavities of the chest; and their use is to convey the atmospheric air into contact with the circulating blood. They consist principally of a cellular texture, and air tubes communicating with the atmosphere through the trachea.—The degree of fleshy consistence and solidity which they have, is owing to the many vessels which carry blood through them, and the firm texture of membrane necessary to support them. Their function is respiration.

RESPIRATION carries away the superfluous carbon of the blood, bestows heat, and stimulates the system, endows us

with the power of speech, and affords us the sense of smelling, or greatly contributes to the perfection of the sense.

In form, the lungs correspond to the cavity which contains them. When taken from their place and extended, they are wide below, forming a base, and rise conically upward; concave where they lie on the arch of the diaphragm, obtuse above, convex forward, and more slightly so on the sides; the borders of the lungs behind are obtuse, pointed and thin before. The lungs have a deep sulcus behind left for the spine, and within the projecting lobes there is a place of lodgement for the pericardium and heart.

Attending to this general form, we see why the lungs are spoken of as double, for unless by the connexion of their common wind-pipe there are two great lateral portions, each of which belongs to a distinct cavity. And when we look to the lungs of the two sides, we discover that they are not perfectly alike. On each lung a fissure begins a little above the apex, and runs obliquely forward and downward to the base. This fissure on the left side divides the lung into two lobes. On the right side there is a lesser fissure, which consequently forms a lesser intermediate triangular lobe.

OF THE TRACHEA AND BRONCHI.

The trachea is that extent of the wind-pipe which is betwixt the LARYNX (already described) and the division of this tube where it is about to enter the lungs. It is seated on the forepart of the neck and anterior to the œsophagus or gullet. It is covered by the thyroid gland and the flat muscles going from the sternum to the os hyoides and thyroid cartilage, and all around, it has a very loose and elastic cellular membrane.

The trachea is not a perfect cylinder, it is flat on the back part; it is rigid to admit of the easy passage of the air through it; and this rigidity is derived from the cartilaginous hoops of which it is principally formed. These are not perfectly regular: above they are most so, and are broader, and have weaker cornua the nearer the bifurcation: they are united by an intermediate ligamentous substance, which appears to be muscular; and these cornuæ have transverse fibres uniting them, which also appear to be muscular.

The membrane lining the trachea, and continued from the larynx into the cells of the lungs is as we have already said a mucous membrane; it is soft, elastic, and vascular; many pores of foramina open upon it, especially about the larynx and epiglottis. These are the openings of the ducts of glands,

and on the outside of the membrane, round and oval glands are visible. The moisture which bedews the trachea is a limpid bland mucus which subsides in water, unless air bubbles be in it. The thinner part of this secretion is carried off by the air which passes through the trachea, and the thick matter is expectorated.

This secretion, which, in the healthy state, is of the consistence of thin jelly, transparent and of a bluish colour, becomes, from inflammation of the catarrhal kind, thinner and more transparent, and is copiously expectorated. In more chronic inflammation, the matter becomes thick, opaque, and of the colour of straw. And in a still later stage, it may come purulent, without implying lesion of surface. The firmer modules of viscid secretion, which are brought up, are probably from the saccula laryngis.

From its exposed situation, its sensibility and vascularity, the membrane of the trachea is very subject to disease. I have now before me examples of general inflammation, of inflammatory crust, of suppuration and deep ulcer in the inside of the trachea. Often lesser degrees of inflammation change the nature of the bland secretion, making it more saline, acrid, and stimulating. Sometimes the inflammatory action will mix a portion of coagulable lymph with the mucus secreted, and which, by this addition, will take a tubular form, as in the croup. But let it be remembered, that coagulable lymph in the form of tubes or vessels may be coughed up from the lungs, a consequence of blood poured into the bronchi without the presence of inflammation.

On entering the thorax, the trachea inclines backward, and passes into the posterior mediastinum, and behind the arch of the aorta, and before the œsophagus; opposite to the third vertebræ of the back it divides into two branches, passing to the right and left: these, and their subdivisions, are the bronchi.

When we follow one of these tubes, we find it entering the substance of the lungs, accompanied by blood-vessels, branches of the pulmonary artery, with their corresponding veins; and lesser arterial branches enter here, which are derived from the aorta, and are called the bronchial arteries.

The bronchi divide and subdivide in regular order, branching, like a tree, through all the substance of the lungs, until their tender extremities terminate in their air cells; for the cartilaginous rings of the bronchi, which, near the trachea, resemble those of the trunk, become weaker and further removed from each other, until the extremities seem only to be membranous tubes.

BRONCHIAL CELLS.

The BRONCHIAL CELLS, into which the air is admitted in respiration, have been represented as very regular sphericles attached to the branches of the bronchi, and having no communication with each other. I rather believe that they are not regular in figure nor in size, and that they freely communicate. Perhaps I am mistaken in supposing I see that the cells not only communicate, but that the air is drawn through them, and made to circulate among them in a series. Taking this as a question to be judged of more by the probable effect of the structure, than by what we can demonstrate, would not the air, in the supposition of its being drawn through the communications from cell to cell, in connexion with the extremity of a branch of the bronchus, be more effectually brought into contact with the blood, than if the extreme branch of the wind-pipe terminated in a cell which had one opening only, and which cell contracted during expiration, only in a slight degree?

On these cells the ultimate branches of the pulmonary arteries and veins ramify and inosculate, and the thin membrane of the cell and the coats of these minute vessels do not prevent the influence of the air upon the circulating blood. My reader must well distinguish betwixt this regular cellular structure, for the admission of air which is drawn through the trachea and bronchi, and that cellular texture of the lungs which is common to them and every part of the body; a tissue which supports the air-cells, the bronchi, and the three several kinds of blood-vessels, and the lymphatics which collectively constitute the substance of the lungs. This common cellular substance supports the air-cells, and unites the lobules, and conveys the vessels to their destination.

Sometimes the air escapes from the proper bronchial cells into thin cellular texture; then there is emphysema of the lungs; then the lungs are distended with air; but that air does not minister to the oxygenation of the blood, on the contrary, the patient dies suffocated. And still more frequently it happens that the lungs being exerted as by difficult respiration, a watery effusion takes place in the common cellular texture of the lungs, which effectually compresses the proper air cells, and after much oppression suffocates.

COURSE OF THE BLOOD IN THE LUNGS.

Coloured water, or size, or oil of turpentine, being injected into the pulmonary artery, returns by the pulmonic veins, running in what is called the lesser circulation. The same fluids being injected into the vein, return by the artery.* The fluid being more forcibly propelled into the pulmonary artery, flows by the trachea, and the exudation of the fluid is facilitated, if the action of respiration be imitated by blowing into the trachea at the time of the injection. These coarse experiments in the dead body prove little ; but the course of the blood from the extreme pulmonic arteries into the veins, having been seen in the membranous lungs of the larcertæ, the chemical phenomena exhibited by respiration, leave little for us to wish further in explanation of the functions of the lungs.†

There are some reflections which naturally occur in taking leave of this subject of respiration, which may have the further effect of confirming in my reader the accurate knowledge of the anatomy.

Although the lungs are very often found adhering to the inside of the chest, and although this union occurs where we cannot discover that the person during life was subject to any inflammation of the chest, yet it is a preternatural appearance. The lungs (covered with the pleura) lie in contact with the sides of the chest, and consequently with the pleura costalis, but without adhesion. They are passive in the motion of respiration. The muscles of respiration clothing the thorax are the agents in this function. The bony and cartilaginous texture of the thorax in the machinery put in motion, and the effect is the dilatation of the lungs ; for as the sides of the chest rise, the lungs being in close contact, they must follow this rising and as the dilatation of the lungs is freely permitted by the entrance of the atmosphere through the trachea into their cells, the effect of the action of the muscles of inspiration is the drawing of the atmospheric air into the bronchial cells, and the contact of that air with the blood circulating in the lungs. In expiration the lungs are equally passive as in inspiration. The muscles which contract the diameters of the thorax, force the compages of bones and cartilages upon the lungs, and compressing them, throw out the air by the trachea.

* In an experiment which was made this season by a pupil of mine, the mercury, which was thrown into the veins of a live ass, was found at the end of a month to be lodged in the cells of the lungs : it had not been forced into the pulmonary veins.

† For the consent or sympathy of the lungs with other parts, see the observations under the head of *Par-vagum*, in the description of the nerves.

That any other idea should arise in the student's mind is owing to two circumstances ; first, the not comprehending the principles of natural philosophy, and puzzling himself with the expression that the air fills the lungs by its weight ; which is true, but it is as true that the milk enters the mouth of a sucking infant by the weight of the atmosphere, or that in using a syringe, it is the weight of air which forces the fluid into the syringe. The air enters the lungs by suction ; the motion of the thorax produces that suction ; or, in other words, the operation of the weight of the air is permitted to take effect by the tendency to a vacuum which the rising of the sides of the thorax produces ; the pressures of the atmosphere then causes the air to descend into the bronchial cells.

The second circumstance which gives occasion to misconception, is the lungs seeming to have a motion independent of the chest.

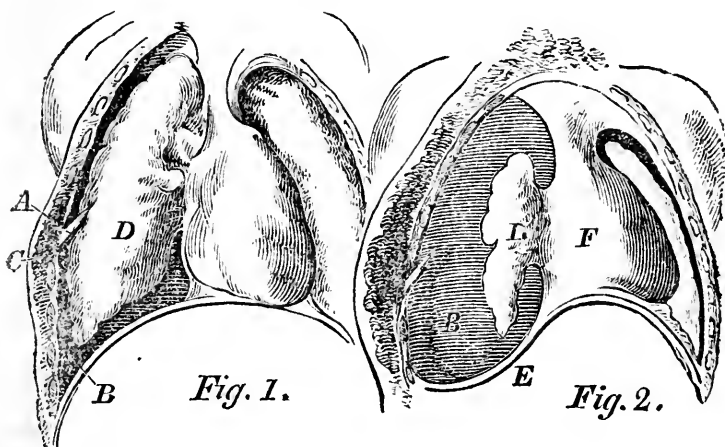
Thus when a man is wounded betwixt the ribs, the lungs protrude, and this rising of the lungs appears to be owing to a power inherent in them ; but attention to the true circumstance will explain the occasion of this. When the wound is received, the air enters the chest, and the lung falls collapsed, the cavity is therefore full of air, and the lobes of the lungs hang loose. The air plays freely out and in through the hole in the chest. But when by change of posture the flapping edge of the lungs fall against the hole in the side, the air which is in the chest can no longer make its exit, without forcing the lungs through the wound. Accordingly, in the act of expiration, the same compression which forces the air out in breathing pushes out the lungs from the side. We may have the proof from anatomy that the lungs lie in close contact with the pleura costalis.

When the intercostal muscles are dissected off, and the pleura costalis exposed, the surface of the lungs is seen in contact with that transparent membrane, and when the pleura is punctured with the lancet, the air rushes in, and visibly the lungs retire in proportion as the air is admitted. This proximity of the lungs to the ribs explains the effect of fracture of these bones in producing the tumour called emphysema, for thus it happens. The broken end of the rib piercing the pleura costalis, tears also the pleura pulmonalis, and breaks the surface of the lungs, and opens the bronchial cells. Now when the chest is expanded, a little air is drawn through the rugged opening, and lodges in the cavity of the chest, (now truly a cavity, the air occupying the space betwixt the lungs and chest.) By little and little the small portion of air which is drawn into the cavity of the chest at each inspiration accumu-

lates until a distressing quantity fills the whole of that side of the chest.

The chest being now full of air, the action of expiration, compressing the air in the chest, it insinuates itself by the side of the fractured ribs into the cellular texture, consequently a crepitating tumour of air is formed over the part hurt, and this quickly extends over the whole body, until the skin is blown up like a sac! and the man is in danger of suffocation. The suffocation is not a consequence of this distention of the cellular substance of the body, but of the fulness of the cavity of the chest on that side wounded. For, at length, the chest being kept distended, and the diaphragm pushed down, and the mediastinum passed to the opposite side, both sides of the chest are oppressed, and the breathing is so checked, that if not quickly relieved the patient would die.

These plans will explain the common case of emphysema;

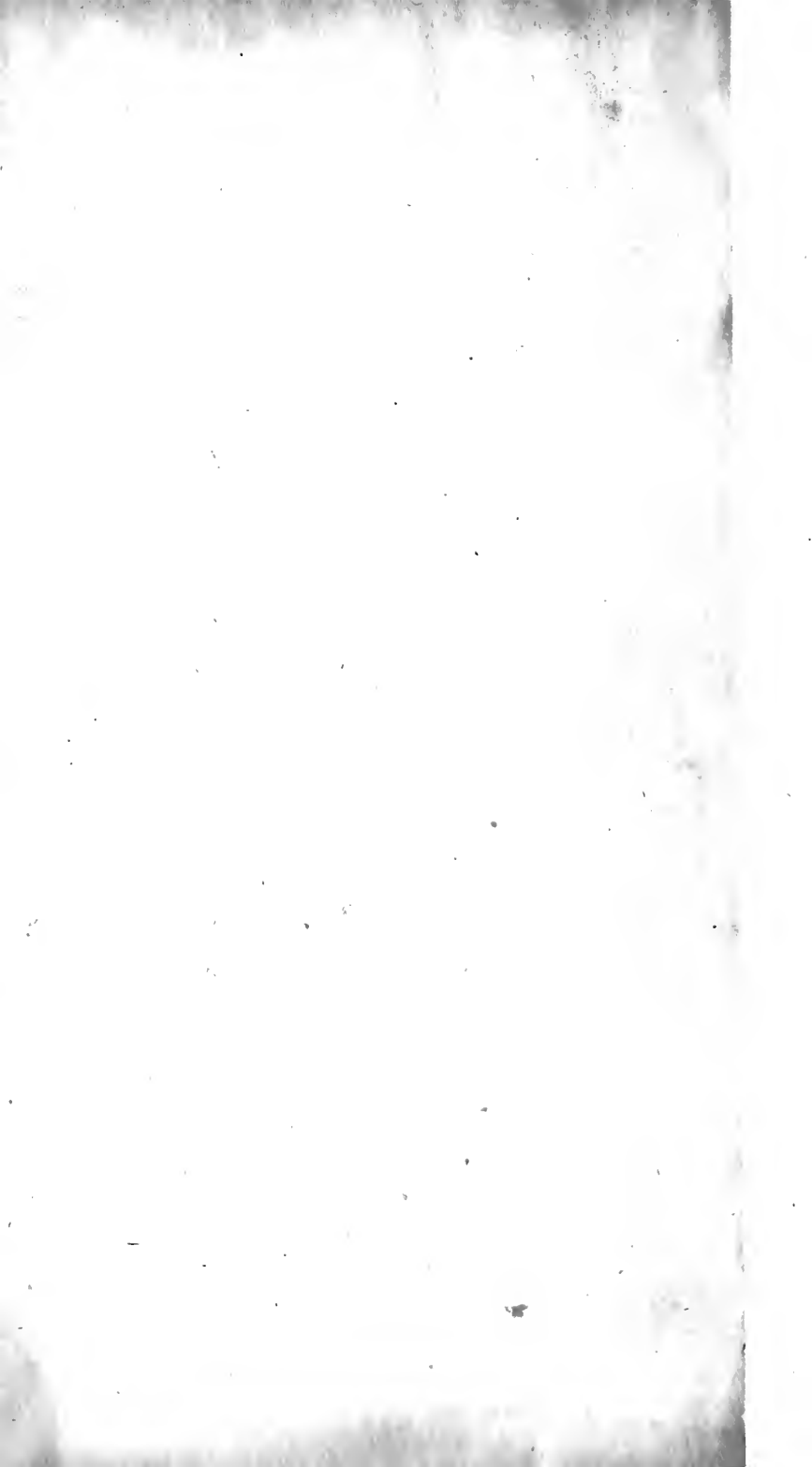


First plan exhibits a section of the thorax, with the rib broken, and entering the lungs A. Air has already begun to accumulate in the cavity of the chest B. The air insinuating itself by the side of the broken rib forms the tumour on the side C. The second plan exhibits the extent of the evil. The lungs are compressed. The cavity of the chest left by the retraction of the lungs is full of air. The emphysematous tumour E is extended over the body. The right side of the diaphragm E is pushed down, the heart and mediastinum F is forced towards the opposite side, encroaching on the lungs of the left side.

The emphysema of the body may take place in a different way. The lungs may be diseased ; air may be drawn through the abscess, and collect in the cavity of the chest ; or the bronchial and true air cells may be hurt by exertion, so that the air gets access into the common cellular texture of the lungs ; and from the lungs it may find its way betwixt the ligaments of the lungs into the cellular texture of the mediastinum, and hence up into the neck and over the body. These last instances are rare compared with that proceeding from fractured rib.

END OF THE FIRST VOLUME.





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